APPENDIX C

Development of Risk-Based Screening Levels

DEVELOPMENT OF RISK-BASED SCREENING LEVELS

Former Pechiney Cast Plate, Inc. Facility

3200 Fruitland Avenue

Vernon, California

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This report was prepared by the staff of AMEC Geomatrix, Inc., under the supervision of the Senior Toxicologists whose signatures appear hereon.

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DEVELOPMENT OF RISK-BASED SCREENING LEVELS

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1.0 INTRODUCTION

Risk-based screening criteria were used to evaluate potential human health risks associated with chemical exposure. Risk-based screening levels (RBSLs) were developed using the methodology presented by the California Environmental Protection Agency (Cal-EPA) Office of Environmental Health Hazard Assessment (OEHHA) for California Human Health Screening Levels (CHHSLs) (2005), the Johnson and Ettinger (1991) model, exposure parameters recommended by DTSC (2005), and recent guidance on lead and total petroleum hydrocarbons (TPH) (OEHHA, 2009a; DTSC, 2009).

A site conceptual model describing the exposure assessment for former Pechiney Cast Plate, Inc. Facility (the Site) is presented in the Feasibility Study (FS) (AMEC, 2009). The receptors identified included a commercial/industrial worker (indoor and outdoor) and a construction worker (outdoor). This appendix presents the toxicity assessment, the development of RBSLs for each receptor for each medium of concern (i.e., soil, soil vapor, and groundwater; as appropriate), and an uncertainty analysis.

2.0 TOXICITY ASSESSMENT

The toxicity criteria for cancer risks and noncancer adverse health effects used in deriving the RBSLs are presented in Table C-1 with the exception of total petroleum hydrocarbon (TPH) mixtures, which are addressed in Section 2.1. The hierarchy of references used for selecting these toxicity criteria is as follows:

1. OEHHA Toxicity Criteria Database, 2009b, or OEHHA Chronic Reference Exposure Levels, 2008;

2. United States Environmental Protection Agency (U.S. EPA) Integrated Risk Information System (IRIS) on-line database, 2009a; and

3. Other U.S. EPA or U.S. Department of Health and Human Services toxicity criteria, as recommended or provided for specific chemicals in U.S. EPA, 2009b, Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites, April, or U.S. EPA, 2004c, Region IX Preliminary Remediation Goals (PRGs). The other U.S. sources include Provisional Peer-Reviewed Toxicity Values (PPRTVs), values from the Agency for Toxic Substances & Disease Registry (ATSDR), values from

the National Center for Environmental Assessment (NCEA), and values from U.S. EPA Health Effects Assessment Summary Tables (HEAST).

In the event that an inhalation reference dose or slope factor was not available, route extrapolation from oral exposure was used in the calculations, unless clear toxicological evidence indicates this extrapolation is inappropriate for a specific chemical. Toxicity criteria for dermal exposure were derived using the oral reference dose (RfD) or cancer slope factor (CSF) without adjustment for reduced gastrointestinal absorption efficiency, consistent with the approach used to derive most CHHSLs (OEHHA 2005). Surrogate toxicity criteria were used when no other criteria were available for a specific chemical. Specific surrogates were chosen based on similarities in chemical structure and expected toxicity. Surrogates used in this assessment are presented in Table C-1.

2.1 TOTAL PETROLEUM HYDROCARBONS

Various mixtures of TPH have been reported in shallow soil (surface to a depth of 15 feet below ground surface [bgs]) at the Site including: TPH as gasoline; TPH as diesel; TPH as motor oil; TPH as Stoddard solvent; total extractable petroleum hydrocarbons (TEPH); total recoverable petroleum hydrocarbons (TRPH); undifferentiated TPH; and TPH as specific hydrocarbon ranges c6-c10, c10-c20, c10-c28, and c21-c28. TPH as Stoddard solvent has also been reported in shallow soil vapor (5 and 15 feet bgs) and groundwater (at 150 feet bgs). However, toxicity criteria for use with these TPH mixtures are not available from the DTSC, OEHHA, or U.S. EPA. DTSC recommends using toxicity criteria specific to the following six groups of aliphatic and aromatic hydrocarbons to evaluate the potential risks from TPH exposure (DTSC, 2009):

- c5-c8 aliphatics
- c6-c8 aromatics
- c9-c18 aliphatics
- c9-c16 aromatics
- c19-c32 aliphatics
- c17-c32 aromatics

As described herein, toxicity criteria were developed for the TPH mixtures detected at the Site by 1) determining the aliphatic and aromatic hydrocarbon ranges typically associated with each mixture, 2) using this information to calculate weighted criteria from the aforementioned groups, and 3) summing these weighted criteria into a single criterion for each mixture (apportion method). For comparative purposes, “worst case” toxicity criteria were also developed by assuming each TPH mixture is composed of 50% aliphatic and 50% aromatic

hydrocarbons (DTSC, 2009), and using the most health-protective toxicity criteria of the DTSC hydrocarbon groups associated with each mixture (worst case method). Toxicity criteria were not derived for TRPH and undifferentiated TPH as the specific hydrocarbon ranges associated with these non-discrete TPH mixtures are not understood. In most cases, other TPH analytical data that could be quantitatively evaluated were available for soil samples analyzed for TRPH and undifferentiated TPH.

2.1.1 Development of Toxicity Criteria for TPH by the Apportion Method

The process followed to develop toxicity criteria for TPH mixtures using weighting or apportioning for the specific DTSC hydrocarbon groups involved the steps described below.

1. *Estimate percentages of the DTSC hydrocarbon groups occurring in each mixture.* To estimate these percentages, the carbon chains and aliphatic/aromatic composition of each TPH mixture was first determined from ATSDR (1999), California Regional Water Quality Control Board, San Francisco Bay Region (SFRWQCB, 2008), Curtis and Thompkins (2009), and/or U.S. EPA (1996b). The percentages of the DTSC hydrocarbon groups occurring in each mixture was then estimated using the following equation (Equation 1):

$$P_x = \frac{HC_x}{HC} \times Ax \qquad (1)$$

Where:
- P_x = percentage of DTSC hydrocarbon group (x) occurring in TPH mixture
- HC_x = number of carbon chain groups from DTSC hydrocarbon group occurring in TPH mixture (e.g., C5 to C8 would be 4)
- HC = total number of carbon chain groups in TPH mixture (e.g., C5 to C12 would be 8)
- A_x = aliphatic (or aromatic) percentage in TPH mixture

The carbon chains and aliphatic/aromatic percentages assigned to each TPH mixture, and the resulting calculated percentages of DTSC hydrocarbon groups occurring in each mixture, are presented in Table C-2.

2. *Normalize the percentages of DTSC hydrocarbon groups as needed.* Because DTSC recommends that individual chemicals of potential concern (COPCs) (e.g., benzene, toluene, ethylbenzene, and xylenes [BTEX]) be used to evaluate c6-c8 aromatics, contributions from this hydrocarbon group were excluded from TPH toxicity criteria development. Such COPCs have been analyzed for at the Site and would be evaluated separately with RBSLs for the individual COPCs. As a result, for the TPH mixtures consisting of some fraction of c6-c8 aromatics (TPH as gasoline, TPH as Stoddard solvent, and c6-c10 hydrocarbons), the contributions of the remaining hydrocarbon groups occurring in those mixtures (c5-c8 aliphatics, c9-c18 aliphatics, and c9-c16 aromatics) would not add up to 100% (Table C-2). To address this issue, the percentages of these groups were normalized. Similarly,

data normalization was also required for the hydrocarbon groups occurring in TPH as motor oil and TEPH. The calculated percentages of these groups did not add up to 100 percent because both mixtures contain c33+ hydrocarbons for which no toxicity criteria have been assigned. Calculated percentages were normalized in these cases using the following equation (Equation 2):

$$NP_x = \frac{P_x}{\sum P_x} \quad (2)$$

Where: NP_x = normalized percentage of DTSC hydrocarbon group occurring in TPH mixture

$\sum P_x$ = percentage sum of all DTSC hydrocarbon groups occurring in TPH mixture

All other terms previously defined.

Normalized percentages for the DTSC hydrocarbon groups occurring in each mixture are presented in Table C-2. Prior to estimating the inhalation RfDs and reference concentrations (RfC) for TPH as diesel, TEPH, c10-c20 hydrocarbons and c10-c28 hydrocarbons, the normalized percentages estimated for the DTSC hydrocarbon groups occurring in these mixtures were re-calculated to account for the low volatility and/or lack of inhalation toxicity criteria of the c19-c32 aliphatics and c17-c32 aromatics. The normalized percentages were re-calculated excluding these two groups.

3. *Calculation of toxicity criteria for each TPH mixture.* In the final step, the toxicity criteria were estimated by summing the DTSC hydrocarbon group criteria, weighted by the percentages estimated in the previous two steps (Equation 3):

$$RfD = \sum (NP_x \times RfD_x) \quad (3)$$

Where: RfD = RfD (or reference concentration [RfC]) for TPH mixture (mg/kg-day) (or µg/m^3 for RfC)

RfD_x = RfD (or RfC) for DTSC hydrocarbon group (mg/kg-day or µg/m^3)

All other terms previously defined

The RfDs and RfCs estimated for each TPH mixture by the apportion method are presented in Table C-2 and listed in Table C-1 as well.

2.1.2 Development of "Worst Case" Toxicity Criteria for TPH

For comparative purposes, a set of worst case criteria were also estimated for the mixtures of TPH detected at the Site, in soil, soil vapor and groundwater samples, by assuming each

mixture consisted of 50% aliphatic and 50% aromatic hydrocarbons (DTSC, 2009) and using the most health-protective toxicity criteria for the hydrocarbon groups associated with each mixture. This assumption is conservative, given that the industry-grade composition of each mixture, as suggested by ATSDR (1999), consists of approximately 65-80% aliphatic hydrocarbons (which are less toxic then aromatic hydrocarbons). Furthermore, once introduced into the environment, the effects of weathering contribute to a reduction in concentration of the lighter, more toxic hydrocarbons of each aliphatic/aromatic fraction.

The worst case toxicity criteria for TPH were calculated as follows (Equation 4):

$$RfD = (0.5 \times RfD_{al}) + (0.5 \times RfD_{ar}) \quad (4)$$

Where:

RfD = RfD (or RfC) for TPH mixture (mg/kg-day or µg/m^3)

RfD_{al} = Most health-protective RfD (or RfC) of the DTSC aliphatic hydrocarbon group within the TPH mixture (mg/kg-day or µg/m^3)

RfD_{ar} = Most health-protective RfD (or RfC) of the DTSC aromatic hydrocarbon group within the TPH mixture (mg/kg-day or µg/m^3)

The worst case RfDs and RfCs estimated for each TPH mixture are presented in Table C-3 and listed in Table C-1 as well.

3.0 RISK-BASED SCREENING LEVELS FOR SOIL

Future exposure for the outdoor commercial/industrial worker and the construction worker was assumed to be complete for chemicals in soil via incidental ingestion, dermal contact, and inhalation of airborne particulates or volatile organic compounds[1] (VOCs) in ambient air. Future exposure for the indoor commercial/industrial worker was assumed to be complete for VOCs moving from subsurface soil into indoor air. However, soil vapor is considered a more appropriate medium than soil for assessing potential vapor migration and shallow soil vapor data (collected at 5 or 15 feet bgs) were used to evaluate potential vapor migration from the vadose zone into indoor and ambient air and subsequent inhalation exposure.

RBSLs were developed for non-volatile chemicals in soil to be protective of outdoor commercial/industrial worker exposure to soil via incidental ingestion, dermal contact, and inhalation of airborne particulates. Additional RBSLs were developed for construction workers for these chemicals following the same methodology but using construction worker exposure

[1] Chemicals are identified as VOCs if the molecular weight is less than 200 grams per mole (g/mole) and the Henry's Law Constant is greater than 1x10^{-5} atmospheres–cubic meter per mole (atm-m^3/mole).

parameters. Soil vapor data were used in place of soil data to evaluate potential vapor movement from the vadose zone into indoor and ambient air. RBSLs were developed for outdoor commercial/industrial workers and construction workers for the VOCs detected in soil to account for potential exposure via soil incidental ingestion and dermal contact. Lead was evaluated separately based on the unique health effects associated with this chemical.

3.1 RISK-BASED SCREENING LEVELS FOR SOIL (NON-LEAD EXPOSURES)

The equations used to develop the RBSLs for soil for both outdoor commercial/industrial workers and construction workers are presented below. RBSLs were developed to screen for both cancer risks (Equation 5) and noncancer adverse health effects (Equation 6). These equations consider exposure via incidental ingestion, dermal exposure, and inhalation of particulates (using a particulate emission factor [PEF]). For VOCs, the inhalation pathway component (third component of denominator in Equations 5 and 6) did not apply in the RBSL calculations.

$$RBSL_{soil-risk} = \frac{TR \times BW \times AT_{ca}}{ED \times EF \times \left[\left(\frac{IR_s \times CSF_o}{CF_{kg-mg}}\right) + \left(\frac{SAs \times SAF \times ABS \times CSF_o}{CF_{kg-mg}}\right) + \left(\frac{IHR_a \times CSF_i}{PEF}\right)\right]} \quad (5)$$

Where:

$RBSL_{soil-risk}$ = risk-based soil screening level for cancer risk (mg/kg)
TR = target cancer risk, 1×10^{-6} (unitless)
BW = body weight (kg)
AT_{ca} = averaging time - cancer (days)
ED = exposure duration (yr)
EF = exposure frequency (days/yr)
IR_s = ingestion rate of soil (mg/day)
CSF_o = oral cancer slope factor [$(mg/kg\text{-}day)^{-1}$]
CF_{kg-mg} = conversion factor from kilograms to milligrams
SAs = exposed skin surface area (cm^2)
SAF = soil-to-skin adherence factor (mg/cm^2)
ABS = dermal absorption factor (unitless)
IHR_a = inhalation rate (m^3/day)
CSF_i = inhalation cancer slope factor [$(mg/kg\text{-}day)^{-1}$]
PEF = particulate emission factor (m^3 of air/kg of soil)

$$RBSL_{soil-haz} = \frac{THQ \times BW \times AT_{nc}}{ED \times EF \times \left[\left(\frac{1}{RfD_o} \times \frac{IR_s}{CF_{kg-mg}}\right) + \left(\frac{1}{RfD_o} \times \frac{SAs \times SAF \times ABS}{CF_{kg-mg}}\right) + \left(\frac{1}{RfD_i} \times \frac{IHR_a}{PEF}\right)\right]} \quad (6)$$

Where:

$RBSL_{soil-haz}$ = risk-based soil screening level for noncancer hazard (mg/kg)
THQ = target hazard quotient, 1 (unitless)
AT_{nc} = averaging time - noncancer (days)

RfD_o = oral reference dose (mg/kg-day)
RfD_i = inhalation reference dose (mg/kg-day)
All other terms previously defined

The toxicity criteria for cancer risks and noncancer adverse health effects used in deriving the RBSLs are presented in Table C-1. Chemical-specific dermal absorption factors used in deriving the RBSLs are presented in Table C-4. Values for exposure parameters used in the RBSL calculations are listed in Tables C-5 and C-6 for outdoor commercial/industrial workers and construction workers, respectively, as obtained from DTSC (2005).

The RBSLs developed to screen the chemical concentrations in soil at the Site and estimate potential outdoor commercial/industrial worker cancer risks and noncancer hazards from exposure to these concentrations are presented in Table C-7. The RBSLs developed to screen the chemical concentrations in soil at the Site and estimate potential construction worker cancer risks and noncancer hazards from exposure to these concentrations are presented in Table C-8.

3.2 RISK-BASED SCREENING LEVELS FOR EXPOSURE TO LEAD IN SOIL

Although a CSF has been published by OEHHA for lead (OEHHA, 2009b), noncarcinogenic health effects, particularly for children, occur at much lower concentrations than carcinogenic effects. Separate mathematical models, such as the U.S. EPA's Adult Lead Model (ALM) (U.S. EPA, 2005) and the LeadSpread model developed by the DTSC (1999), have been developed to evaluate these potential health concerns by estimating blood-lead levels resulting from contact with lead in various media (e.g., soil, air, food). The blood-lead level is of interest because most adverse human health effects are correlated in terms of blood-lead levels (e.g., a blood-lead level of "x" is associated with an increased incidence of adverse health effects). In contrast, risks and adverse health effects for other chemicals are correlated simply in terms of chemical intake.

The U.S. EPA's ALM and DTSC's LeadSpread model were used to develop health-based screening levels for outdoor commercial/industrial worker and construction worker exposure to total lead in soil that are protective of benchmark blood-lead levels established by the DTSC (1999) and OEHHA (2009a). For commercial/industrial workers, the health-based screening level was based on a 90th percentile estimate of a 1 microgram per deciliter (µg/dL) incremental change in the blood-lead level of the fetus of an adult worker (OEHHA, 2009a). For construction workers, the health-based screening level was based on a 99th percentile 10 µg/dL blood-lead level of concern (DTSC, 1999). Leadspread was used assuming construction work would not be performed by childbearing adults. Using the ALM, the health-based screening level for commercial/industrial workers was calculated using U.S. EPA-

recommended exposure parameters, with adjustments to the blood-lead geometric standard deviation, baseline blood-lead level, and exposure frequency of adult workers to be consistent with OEHHA recommendations (2009a). Using LeadSpread, the health-based screening level for construction workers was calculated using default background concentrations of lead in other environmental media (e.g., air, food, water) and default exposure parameters recommended by DTSC for use with LeadSpread, with a few exceptions. Values used in the derivation of the other RBSLs were used in place of the default LeadSpread values for exposed skin surface area and soil-to-skin adherence factor; the default LeadSpread values for these parameters are intended for commercial/industrial workers and adult residents, respectively. Finally, a soil ingestion rate equivalent to 50 percent of the ingestion rate used in the derivation of the other RBSLs was used for construction workers. This adjustment is consistent with recommended soil ingestion rates by DTSC for use with LeadSpread for other receptors (i.e., residents and workers). Attachment B-1 presents the ALM calculations and Attachment B-2 presents the LeadSpread calculations used in the derivation of the health-based screening levels for outdoor commercial/industrial workers and construction workers, respectively. The resulting health-based screening levels are summarized in Table C-9.

4.0 RISK-BASED SCREENING LEVELS FOR SOIL VAPOR

As described above, future exposure for the indoor commercial/industrial worker was assumed to be complete for chemicals moving from subsurface vadose zone soil into indoor air. Similarly, for the outdoor commercial/industrial worker and construction worker assumed to spend 100 percent of their time outdoors, future exposure was considered complete for chemicals moving from subsurface vadose zone soil into ambient air. RBSLs were developed for soil vapor concentrations to evaluate vapor movement from the vadose zone into indoor or ambient air.

4.1 RISK-BASED SCREENING LEVELS FOR MOVEMENT OF VOCS TO INDOOR AIR

This section presents the derivation of RBSLs for movement of VOCs in shallow soil vapor to indoor air for indoor commercial/industrial workers. RBSLs were not derived for construction workers as these receptors are not considered to spend sufficient time indoors to warrant evaluation via this exposure pathway. The soil vapor RBSLs developed for indoor air exposures were based on the methodology for soil vapor CHHSLs for current, common slab on grade building construction practices in California, in which a building foundation is separated from underlying soil by a layer of compacted, fine-grained cohesive soil and a layer of sub-slab gravel (OEHHA, 2005). Transport of chemical vapors from shallow soil vapor into indoor air is predicted by the Johnson and Ettinger (1991) model. The process followed to

develop these RBSLs is based on the process presented in Appendix B of the OEHHA guidance (2005) and involves three consecutive steps:

1. *Calculation of target indoor air concentrations.* The equations used to develop the target indoor air concentrations for indoor commercial/industrial workers are presented below, based on the equations presented in Appendix B of OEHHA (2005), but accounting for the use of DTSC-recommended inhalation rates (DTSC, 2005). Target indoor air concentrations were developed for both cancer risks (Equation 7) and noncancer adverse health effects (Equation 8):

$$C_{ia-risk} = \frac{TR \times BW \times AT_{ca} \times CF_{mg-ug}}{IHR_a \times EF \times ED \times CSF_i} \quad (7)$$

Where: $C_{ia\text{-}risk}$ = target indoor air concentration for cancer risks (µg/m^3)
$CF_{mg\text{-}ug}$ = conversion factor from milligrams to micrograms
All other terms previously defined

$$C_{ia-haz} = \frac{THQ \times BW \times AT_{nc} \times CF_{mg-ug}}{IHR_a \times EF \times ED \times 1/RfD_i} \quad (8)$$

Where: $C_{ia\text{-}haz}$ = target indoor air concentration for noncancer hazard (µg/m3)
All other terms previously defined

Values of exposure parameters used in the target indoor air concentration calculations are listed in Table C-10, as obtained from DTSC (2005). The toxicity criteria for cancer risks and noncancer adverse health effects used in deriving the target indoor air concentrations are presented in Table C-1.

2. *Use of the Johnson and Ettinger (1991) model to calculate chemical-specific, soil vapor-to-indoor air attenuation factors.* The attenuation factors provided by the Johnson and Ettinger (1991) model relate vapor concentrations in indoor air to vapor concentrations in the subsurface by accounting for the one-dimensional convective and diffusive mechanisms of vapor transport from the subsurface into indoor air. Consistent with OEHHA (2005), the advanced Johnson and Ettinger model spreadsheets for subsurface vapor intrusion from soil parameterized by U.S. EPA were used to calculate the attenuation (Attachment C-1). Inputs to the advanced model spreadsheets include chemical properties, and unsaturated zone soil properties for sand from OEHHA, 2005; conservative assumptions regarding other parameters (i.e., structural properties of the building) were based on default values in the model (OEHHA, 2005).

3. *Calculation of the soil vapor RBSLs.* The soil vapor RBSLs were estimated from the calculated target indoor air concentrations and attenuation factors using the following equation:

$$RBSL_{soil\ vapor-ia} = \frac{C_{ia}}{\alpha \times CF_{m3-L}} \quad (9)$$

Where: $RBSL_{soil\ vapor-ia}$ = risk-based screening level for soil vapor, indoor air (µg/L)
C_{ia} = target indoor air concentration (µg/m^3)
α = chemical-specific attenuation factor (unitless)
CF_{m3-L} = conversion factor from cubic meters to liters

The target commercial/industrial worker indoor air concentrations, attenuation factors, and soil vapor RBSLs estimated for the chemicals detected in soil vapor at the Site are presented in Table C-11.

4.2 RISK-BASED SCREENING LEVELS FOR SOIL VAPOR FOR MOVEMENT OF VOCS TO AMBIENT AIR

RBSLs were developed for the chemical concentrations in soil vapor to be protective of potential commercial/industrial worker or construction worker exposure to the concentrations of these chemicals that may move into ambient air. The process followed to develop these RBSLs is comparable to the one outlined above for developing soil vapor RBSLs for indoor air exposure, but involves the use of different models to predict vapor flux and dispersion of chemicals from subsurface soil vapor to ambient air:

1. *Calculation of target ambient air concentrations for both cancer risks and noncancer adverse health effects.* The equations used to develop the target ambient air concentrations for outdoor commercial/industrial workers and construction workers are equivalent to the equations used to develop the target indoor air concentrations (Equations 7 and 8 above). Values of exposure parameters used in the target ambient air concentration calculations are listed in Tables C-5 and C-6 for the outdoor commercial/industrial workers and construction workers, respectively. The toxicity criteria for cancer risks and noncancer adverse health effects used in deriving the target ambient air concentrations are presented in Table C-1.

2. *Use of the X/Q Model to calculate subsurface vapor flux from the target ambient air concentrations.* The X/Q dispersion model presented in "Soil Screening Guidance: Users Guide and Technical Background Document" (U.S. EPA, 1996a) allows for the prediction of ambient air concentrations of VOCs from a known or estimated subsurface vapor emission rate. The relationship established by the X/Q dispersion model of subsurface vapor flux to ambient air concentration was used to estimate the subsurface vapor emission rate associated with each target ambient air concentration:

$$E_i = \frac{C_{oa}}{X/Q} \quad (10)$$

Where:
- E_i = emission rate (µg/m^2-sec)
- C_{oa} = target ambient air concentration (µg/m^3)
- X/Q = Dispersion factor (mg/m^3 per mg/m^2-sec); calculated from the inverse dispersion factor as presented in supporting equations in Attachment A-1.

3. *Use of the VOC Emission Model to calculate soil vapor screening levels from estimated subsurface vapor flux.* After the subsurface vapor flux was estimated, the VOC Emission Model presented in "Soil Screening Guidance: Users Guide and Technical Background Document" (U.S. EPA, 1996a) was used to estimate the soil vapor RBSL for ambient air exposures. First the total solute concentration associated with soil vapor was estimated as follows:

$$CT = \frac{E_i \times \sqrt{\pi \times Da \times T}}{2 \times Da \times CF_{m2-cm2}} \quad (11)$$

Where:
- CT = total solute concentration (µg/cm^3)
- E_i = emission rate (µg/m^2-sec)
- Da = chemical-specific effective diffusivity in soil pore space (cm^2/sec); calculated as presented in Attachment A-1, using site-specific assumptions presented in Attachment A-2 and chemical-specific parameters presented in Table C-4
- T = exposure interval (sec) (equal to exposure duration)
- $CF_{m2\text{-}cm2}$ = conversion factor from square meters to square centimeters

The total solute concentration was then used to derive the soil vapor RBSL via the partitioning predicted by Henry's law:

$$RBSL_{soil\ vapor-oa} = \frac{CT}{[(pb \times Kd/H') + Pw/H' + Pa] \times CF_{cm3-L}} \quad (12)$$

Where:
- $RBSL_{soil\ vapor\text{-}oa}$ = risk-based screening level for soil vapor, ambient air (µg/L)
- ρ_b = soil bulk density (g/cm^3)
- Kd = soil-organic partition coefficient (cm^3/g)
- H' = Henry's Law constant (unitless)
- Pw = water-filled soil porosity (unitless)
- Pa = air-filled soil porosity (unitless)
- $CF_{cm3\text{-}L}$ = conversion factor from cubic centimeters to liters

All other terms previously defined

The soil vapor RBSLs developed for commercial/industrial workers and construction workers for inhalation of ambient air are presented in Tables C-12 and C-13, respectively.

4.3 RISK-BASED SCREENING LEVELS FOR TPH AS STODDARD SOLVENT IN SOIL VAPOR

TPH as Stoddard solvent was detected in shallow soil vapor at the Site. To develop RBSLs protective of potential subsurface vapor movement of Stoddard solvent into indoor or ambient air, soil vapor RBSLs were developed for the volatile aliphatic and aromatic hydrocarbon groups in the mixture, and the resulting RBSLs were then weighted and summed to estimate RBSLs for Stoddard solvent. The process was similar to the apportion method used to develop toxicity criteria for Stoddard solvent as described in Section 2.1.1, but applied to the RBSLs instead of toxicity criteria. This step was necessary because the chemical properties used to estimate volatilization are based on the TPH hydrocarbon groups and cannot be simply averaged. Soil vapor RBSLs were developed for c5-c8 aliphatics, c9-c18 aliphatics, and c9-c16 aromatics, using toxicity criteria and chemical properties recommended by DTSC (2009). Soil vapor RBSLs were not developed for the c6-c8 aromatic fraction, consistent with previous methods (developing toxicity criteria for TPH mixtures; Section 2.1). The individual COPCs associated with this fraction (e.g., BTEX) have been analyzed for at the Site and would be evaluated separately with individual RBSLs for these COPCs.

To develop the soil vapor RBSLs for c5-c8 aliphatics, c9-c18 aliphatics, and c9-c16 aromatics, the DTSC chemical properties for these fractions were used in the advanced Johnson and Ettinger model spreadsheets to calculate soil vapor-to-indoor air attenuation factors (Attachment C-1). The chemical properties used in the calculation of RBSLs for ambient air exposures are listed in Table C-4. The DTSC toxicity criteria for these fractions are presented in Tables C-11 through C-13 with the resulting soil vapor RBSLs for indoor commercial/ industrial workers, outdoor commercial/industrial workers, and construction workers, respectively. The soil vapor RBSLs for these fractions were then weighted in the calculation of Stoddard solvent RBSLs for all three receptors using previously calculated normalized percentages. The resulting RBSLs for TPH as Stoddard solvent in soil vapor are presented in Table C-14.

Worst case RBSLs were also developed assuming Stoddard solvent is composed of 50% aliphatic and 50% aromatic hydrocarbons (DTSC, 2009) (instead of 80% aliphatics/20% aromatics identified by ATSDR [1999]), and using the most health-protective RBSLs of the volatile aliphatic and aromatic hydrocarbon groups within the mixture. For Stoddard solvent, the RBSLs developed for c9-c18 aliphatics and c9-c16 aromatics were used, with the resulting worst case RBSLs calculated as presented in Table C-14.

5.0 RISK-BASED SCREENING LEVELS FOR GROUNDWATER

RBSLs were developed for the VOCs detected in groundwater to be protective of potential inhalation exposures to concentrations that may move into indoor air. The RBSLs were developed independent of the RBSLs developed for soil vapor described in Section 4.0 above to differentiate vadose zone from groundwater contamination. RBSLs were only developed for potential vapor movement into indoor air to simplify the analysis since these concentrations would also be protective of receptors exposed to ambient air (i.e., outdoor commercial/ industrial workers and construction workers).

RBSLs were developed using the Johnson and Ettinger (1991) model for subsurface vapor intrusion from groundwater. Specifically, the "Calculate Risk-based Groundwater Concentration" function in the advanced Johnson and Ettinger model spreadsheets parameterized by U.S. EPA were used to calculate the RBSLs. Inputs to the advanced model spreadsheets include site-specific unsaturated zone soil properties based on the logs of borings 125 and 126, which were advanced to groundwater at the Site (approximately 150 feet bgs). Because similar lithology has been encountered throughout the Site (Section 2.3.2.1 of the FS), the soil lithologic properties assigned to the Johnson and Ettinger model spreadsheets based on the lithologic profile from these two borings was considered representative of site-wide conditions. Conservative assumptions regarding other parameters (i.e., structural properties of future buildings) were based on default values in the model. All input parameters provided to the model are summarized in Attachment D-1. The model spreadsheets used to estimate the RBSLs are provided in Attachment D-2. A summary of the resulting RBSLs is provided in Table 2 of the FS.

5.1 RISK-BASED SCREENING LEVELS FOR TPH AS STODDARD SOLVENT IN GROUNDWATER

With TPH as Stoddard solvent detected in groundwater at the Site, an RBSL protective of potential vapor intrusion from groundwater was developed following the same process described above for TPH as Stoddard solvent in soil vapor (Section 4.3). Groundwater RBSLs were developed for the volatile aliphatic and aromatic hydrocarbon groups in the mixture as discussed in Section 5.0 and presented in Attachment D. The resulting RBSLs were subsequently weighted using previously calculated normalized percentages, and then summed. The resulting RBSL for TPH as Stoddard solvent in groundwater is presented in Table C-15.

For comparison, a worst case RBSL was also developed assuming Stoddard solvent is composed of 50% aliphatic and 50% aromatic hydrocarbons (DTSC, 2009), and using the most health-protective RBSLs developed for the volatile fractions in the mixture. The RBSLs

developed for c9-c18 aliphatics and c9-c16 aromatics were used, with the resulting worst case RBSL calculated as presented in Table C-15.

6.0 UNCERTAINTY ANALYSIS

Uncertainties are inherent in the development of RBSLs, and the use of these values to derive estimates of potential cancer risk and noncancer health hazards. In the development of screening levels, uncertainty arises from a lack of knowledge of toxicity and dose-response of the chemicals, and the extent to which an individual will be exposed to those chemicals (U.S. EPA, 1989). Assumptions are made based on information presented in the scientific literature or professional judgment. While some assumptions have significant scientific basis, others have less scientific basis. The assumptions that introduce the greatest amount of uncertainty in the development of RBSL are discussed below, consistent with U.S. EPA requirements (1989). Uncertainties associated with other aspects of the risk assessment process, such as site characterization, data evaluation, and the use of screening levels in risk characterization, are presented in the report.

6.1 ENVIRONMENTAL FATE AND TRANSPORT

Fate and transport models were used in the development of RBSLs to predict the movement of vapors into indoor and ambient air. While some site-specific conditions were incorporated into the analysis, the models are screening-level models, which typically are conservative and predict concentrations that overestimate risk. For example, biodegradation of petroleum hydrocarbon constituents in the vadose zone is not considered by the model. In addition, conservative assumptions about future building design have been incorporated into the indoor air model (e.g., slab-on-grade foundations). The development of RBSLs is therefore dependent on future building conditions being consistent with those included in the model.

6.2 EXPOSURE ASSUMPTIONS AND PARAMETERS

The exposure parameters used to derive the RBSLs are based on reasonable maximum exposure (RME), which is defined by U.S. EPA as the highest exposure that could reasonably be expected to occur for a given exposure pathway at a site (U.S. EPA, 1989). The exposure parameters associated with a RME scenario are therefore highly conservative. For example, under RME conditions, it is assumed that a commercial/industrial worker is present on-site for 250 days per year for 25 years. The use of such upper-bound estimates in the development of RBSL most likely results in overly protective values.

6.3 TOXICITY CRITERIA

One of the largest sources of uncertainty in any risk assessment is associated with the scientific community's limited understanding of the toxicity of most chemicals in humans following exposure to the low concentrations generally encountered in the environment. The majority of available toxicity data are from animal studies, which are then extrapolated using mathematical models or multiple uncertainty factors to generate toxicity criteria used to predict what might occur in humans. Sources of conservatism in the toxicity criteria used in this evaluation include:

- the use of conservative methods and assumptions to extrapolate from high dose animal studies to predict the possible response in humans at exposure levels far below those administered to animals;
- the assumption that chemicals considered to be carcinogens do not have thresholds (i.e., for all doses greater than zero, some risk is assumed to be present); and
- the fact that epidemiological studies (i.e., human exposure studies) are limited and are not generally considered in a quantitative manner in deriving toxicity values.

The toxicity criteria used in the development of RBSLs were developed using different methods. The noncarcinogenic criteria (i.e., oral and inhalation RfDs) incorporate multiple safety factors to account for limitations in the quality or quantity of available data (e.g., animal data in lieu of human data). These safety factors are applied without regard to available data on the true likelihood of a variation in human response. Therefore, RfDs may be hundreds of times smaller than doses that would actually cause adverse health effects. This purposeful bias in the development of RfDs overestimates the actual potential for noncarcinogenic health risks for these chemicals.

The carcinogenic toxicity criteria (i.e., oral and inhalation CSFs) also are developed using techniques that purposefully bias the criteria toward health conservatism. For example, most CSFs are based on the premise that cancer data from high dose animal studies will predict cancer response in humans at dose levels thousands of times lower. The process also assumes that the carcinogenicity of a chemical in an animal model is representative of the response in humans. Finally, the statistical techniques used by regulatory agencies to extrapolate data from animals to human exposures generally assume that the dose-response curve is linear and that the 95% upper confidence limit of the mean of the slope is representative of the chemical's carcinogenic potency. In aggregate, these assumptions overestimate the actual risk estimates such that they are unlikely to be higher, but could be considerably lower and, in fact, could be non-existent.

A second uncertainty associated with toxicity criteria is the unavailability of RfDs or CSFs for all chemicals at the Site. RBSLs can only be derived for those chemicals for which the relevant toxicity criteria are available. In the absence of data for the inhalation route of exposure, the CSF or RfD for the oral route for these chemicals was used in the evaluation. As a result, the RBSLs for these chemicals may be over- or underestimated. Further, the use of oral toxicity values to assess the dermal pathway introduces additional uncertainty into the results; RBSLs may be overestimated or underestimated using this approach as well. Lastly, in just a few cases, surrogate chemicals were used to represent the toxicity of other chemicals. While the selection and use of surrogates for toxicity criteria is not ideal, the surrogates selected for use in the HHRA were all very closely structurally related to the contaminants they were chosen to represent. A lack of a toxicity criterion would otherwise remain a data gap. The degree of uncertainty contributed by the use of surrogates in this manner is unknown but is not expected to result in significant underestimates of risk.

7.0 REFERENCES

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TABLE C-1
TOXICITY CRITERIA FOR CHEMICALS OF POTENTIAL CONCERN
Former Pechiney Cast Plate, Inc. Facility
Vernon, California

Chemical	Surrogate	Carcinogenic Toxicity Criteria												Chronic Noncarcinogenic Toxicity Criteria										
		Oral				Dermal	Inhalation							Oral			Dermal	Inhalation						
		OEHHA CSFo[1]	U.S. EPA CSFo[2]	Other CSFo[3]	Final CSFo[4]	CSFd[5]	OEHHA URF[1]	OEHHA CSFi[6]	U.S. EPA URF[2]	U.S. EPA CSFi[6]	Other URF[3]	Other CSFi[6]	Final CSFi[4]	U.S. EPA RfDo[2]	Other RfDo[3]	Final RfDo[7]	RfDd[5]	OEHHA REL[1]	OEHHA RfDi[8]	U.S. EPA RfC[2]	U.S. EPA RfDi[8]	Other RfC[3]	Other RfDi[8]	Final RfDi[4]
		(mg/kg-day)$^{-1}$	(mg/kg-day)$^{-1}$	(mg/kg-day)$^{-1}$	(mg/kg-day)$^{-1}$	(mg/kg-day)$^{-1}$	(µg/m^3)$^{-1}$	(mg/kg-day)$^{-1}$	(µg/m^3)$^{-1}$	(mg/kg-day)$^{-1}$	(µg/m^3)$^{-1}$	(mg/kg-day)$^{-1}$	(mg/kg-day)$^{-1}$	(mg/kg-day)	(mg/kg-day)	(mg/kg-day)	(mg/kg-day)	(µg/m^3)	(mg/kg-day)	(µg/m^3)	(mg/kg-day)	(µg/m^3)	(mg/kg-day)	(mg/kg-day)
Polychlorinated Biphenyls (PCBs)																								
Aroclor-1232	"high-risk" PCBs (slope factors)	2.00E+00	2.00E+00	--	2.00E+00	2.00E+00	5.70E-04	2.00E+00	5.70E-04	2.00E+00	--	NA	2.00E+00	NA	--	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1248	"high-risk" PCBs (slope factors)	2.00E+00	2.00E+00	--	2.00E+00	2.00E+00	5.70E-04	2.00E+00	5.70E-04	2.00E+00	--	NA	2.00E+00	NA	--	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1254	"high-risk" PCBs (slope factors)	2.00E+00	2.00E+00	--	2.00E+00	2.00E+00	5.70E-04	2.00E+00	5.70E-04	2.00E+00	--	NA	2.00E+00	2.00E-05	NA	2.00E-05	2.00E-05	NA	NA	NA	NA	NA	2.00E-05 r	2.00E-05
Aroclor-1260	"high-risk" PCBs (slope factors)	2.00E+00	2.00E+00	--	2.00E+00	2.00E+00	5.70E-04	2.00E+00	5.70E-04	2.00E+00	--	NA	2.00E+00	NA	--	NA	NA	NA	NA	NA	NA	NA	NA	NA
Metals																								
Arsenic		1.50E+00	1.50E+00	--	1.50E+00	1.50E+00	3.30E-03	1.20E+01	4.30E-03	1.51E+01	--	NA	1.20E+01	3.00E-04	NA	3.00E-04	3.00E-04	1.50E-02	4.29E-06	NA	NA	NA	NA	4.29E-06
Barium		NA	NC	NA	NC	NC	NA	NA	NC	NC	NA	NA	NC	2.00E-01	NA	2.00E-01	2.00E-01	NA	NA	NA	NA	5.00E-01 h	1.43E-04	1.43E-04
Beryllium		NA	NA	NA	NA	NA	2.40E-03	8.40E+00	2.40E-03	8.40E+00	--	NA	8.40E+00	2.00E-03	NA	2.00E-03	2.00E-03	7.00E-03	2.00E-06	2.00E-02	5.71E-06	NA	NA	2.00E-06
Cadmium		NA	NA	NA	NA	NA	4.20E-03	1.50E+01	1.80E-03	6.30E+00	--	NA	1.50E+01	5.00E-04	NA	5.00E-04	5.00E-04	2.00E-02	5.71E-06	NA	NA	1.00E-02 a	2.86E-06	5.71E-06
Chromium (total)	Total Cr (inhalation slope factor) Chromium III (oral reference dose)	NA	NA	NA	NA	NA	NA	NA	1.20E-02	4.20E+01	--	NA	4.20E+01	1.50E+00	NA	1.50E+00	1.50E+00	NA	NA	NA	NA	NA	1.50E+00 r	1.50E+00
Chromium VI		NA	NA	NA	NA	NA	1.50E-01	5.10E+02	8.40E-02	2.94E+02	--	NA	5.10E+02	3.00E-03	NA	3.00E-03	3.00E-03	2.00E-01	5.71E-05	1.00E-01	2.86E-05	NA	NA	5.71E-05
Cobalt		NA	NA	NA	NA	NA	NA	NA	NA	NA	9.00E-03 p	3.15E+01	3.15E+01	NA	3.00E-04 p	3.00E-04	3.00E-04	NA	NA	NA	NA	6.00E-03 p	1.71E-06	1.71E-06
Copper		NA	NC	NA	NC	NC	NA	NA	NC	NC	NA	NA	NC	NA	4.00E-02 h	4.00E-02	4.00E-02	NA	NA	NA	NA	NA	3.70E-02 r	3.70E-02
Lead		NA	NA	NA	NA	NA	NA	NA	NA	NA	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	Mercuric chloride (oral reference dose)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3.00E-04	NA	3.00E-04	3.00E-04	3.00E-02	8.57E-06	NA	NA	NA	NA	8.57E-06
Molybdenum		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.00E-03	NA	5.00E-03	5.00E-03	NA	NA	NA	NA	NA	5.00E-03 r	5.00E-03
Nickel		NA	NA	NA	NA	NA	2.60E-04	9.10E-01	NA	NA	--	NA	9.10E-01	2.00E-02	NA	2.00E-02	2.00E-02	5.00E-02	1.43E-05	NA	NA	9.00E-02 a	2.57E-05	1.43E-05
Selenium		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.00E-03	NA	5.00E-03	5.00E-03	2.00E+01	5.71E-03	NA	NA	NA	NA	5.71E-03
Silver		NA	NC	NA	NC	NC	NA	NA	NC	NC	NA	NA	NC	5.00E-03	NA	5.00E-03	5.00E-03	NA	NA	NA	NA	NA	5.00E-03 r	5.00E-03
Thallium		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	6.50E-05	NA	6.50E-05	6.50E-05	NA	NA	NA	NA	NA	8.00E-05 r	8.00E-05
Vanadium		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.00E-03 h	7.00E-03	7.00E-03	NA	NA	NA	NA	NA	7.00E-03 r	7.00E-03
Zinc		NA	NC	NA	NC	NC	NA	NA	NC	NC	NA	NA	NC	3.00E-01	NA	3.00E-01	3.00E-01	NA	NA	NA	NA	NA	3.00E-01 r	3.00E-01
Total Petroleum Hydrocarbons (Apportion Method)																								
TPH as gasoline		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.30E-02 calc	5.30E-02	5.30E-02	NA	NA	NA	NA	4.50E+02 calc	1.30E-01 calc	1.30E-01
TPH as diesel		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.70E-01 calc	5.70E-01	5.70E-01	NA	NA	NA	NA	1.30E+02 calc	3.60E-02 calc	3.60E-02
TPH as motor oil		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.51E+00 calc	1.51E+00	1.51E+00	NA	NA	NA	NA	NA calc	NA calc	NA
TPH as Stoddard solvent		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	6.90E-02 calc	6.90E-02	6.90E-02	NA	NA	NA	NA	3.80E+02 calc	1.10E-01 calc	1.10E-01
TEPH		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8.90E-01 calc	8.90E-01	8.90E-01	NA	NA	NA	NA	8.70E+01 calc	2.50E-02 calc	2.50E-02
c6-c10 hydrocarbons		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.30E-02 calc	5.30E-02	5.30E-02	NA	NA	NA	NA	4.50E+02 calc	1.30E-01 calc	1.30E-01
c10-c20 hydrocarbons		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.90E-01 calc	2.90E-01	2.90E-01	NA	NA	NA	NA	1.70E+02 calc	4.90E-02 calc	4.90E-02
c10-c28 hydrocarbons		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.20E-01 calc	7.20E-01	7.20E-01	NA	NA	NA	NA	9.90E+01 calc	2.80E-02 calc	2.80E-02
c21-c28 hydrocarbons		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.31E+00 calc	1.31E+00	1.31E+00	NA	NA	NA	NA	NA calc	NA calc	NA
Total Petroleum Hydrocarbons (Worst Case)																								
TPH as gasoline		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.20E-02 calc	2.20E-02	2.20E-02	NA	NA	NA	NA	1.80E+02 calc	5.00E-02 calc	5.00E-02
TPH as diesel		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.20E-02 calc	5.20E-02	5.20E-02	NA	NA	NA	NA	1.80E+02 calc	5.00E-02 calc	5.00E-02
TPH as motor oil		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.02E+00 calc	1.02E+00	1.02E+00	NA	NA	NA	NA	NA calc	NA calc	NA
TPH as Stoddard solvent		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.20E-02 calc	2.20E-02	2.20E-02	NA	NA	NA	NA	1.80E+02 calc	5.00E-02 calc	5.00E-02
TEPH		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.20E-02 calc	5.20E-02	5.20E-02	NA	NA	NA	NA	1.80E+02 calc	5.00E-02 calc	5.00E-02
c6-c10 hydrocarbons		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.20E-02 calc	2.20E-02	2.20E-02	NA	NA	NA	NA	1.80E+02 calc	5.00E-02 calc	5.00E-02
c10-c20 hydrocarbons		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.20E-02 calc	5.20E-02	5.20E-02	NA	NA	NA	NA	1.80E+02 calc	5.00E-02 calc	5.00E-02
c10-c28 hydrocarbons		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.20E-02 calc	5.20E-02	5.20E-02	NA	NA	NA	NA	1.80E+02 calc	5.00E-02 calc	5.00E-02
c21-c28 hydrocarbons		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.02E+00 calc	1.02E+00	1.02E+00	NA	NA	NA	NA	1.80E+02 calc	NA calc	NA
Volatile Organic Compounds (VOCs)																								
Acetone		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	9.00E-01	NA	9.00E-01	9.00E-01	NA	NA	NA	NA	3.10E+04 a	8.86E+00	8.86E+00
Benzene		1.00E-01	5.50E-02	--	1.00E-01	1.00E-01	2.90E-05	1.00E-01	7.80E-06	2.73E-02	--	NA	1.00E-01	4.00E-03	NA	4.00E-03	4.00E-03	6.00E+01	1.71E-02	3.00E+01	8.57E-03	NA	NA	1.71E-02
2-Butanone (MEK)		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	6.00E-01	NA	6.00E-01	6.00E-01	NA	NA	5.00E+03	1.43E+00	NA	NA	1.43E+00
n-Butylbenzene		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4.00E-02 n	4.00E-02	4.00E-02	NA	NA	NA	NA	NA	4.00E-02 r	4.00E-02
sec-Butylbenzene		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4.00E-02 n	4.00E-02	4.00E-02	NA	NA	NA	NA	NA	4.00E-02 r	4.00E-02
Carbon Tetrachloride		1.50E-01	1.30E-01	--	1.50E-01	1.50E-01	4.20E-05	1.50E-01	1.50E-05	5.25E-02	--	NA	1.50E-01	7.00E-04	NA	7.00E-04	7.00E-04	4.00E+01	1.14E-02	NA	NA	1.90E+02 a	5.43E-02	1.14E-02
Chloroform		3.10E-02	NA	--	3.10E-02	3.10E-02	5.30E-06	1.90E-02	2.30E-05	8.05E-02	--	NA	1.90E-02	1.00E-02	NA	1.00E-02	1.00E-02	3.00E+02	8.57E-02	NA	NA	9.80E+01 a	2.80E-02	8.57E-02
1,2-Dichloroethane (EDC)		4.70E-02	9.10E-02	--	4.70E-02	4.70E-02	2.10E-05	7.20E-02	2.60E-05	9.10E-02	--	NA	7.20E-02	NA	2.00E-02 p	2.00E-02	2.00E-02	NA	NA	NA	NA	2.40E+03 a	6.86E-01	6.86E-01
1,1-Dichloroethylene		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.00E-02	NA	5.00E-02	5.00E-02	7.00E+01	2.00E-02	2.00E+02	5.71E-02	NA	NA	2.00E-02
cis-1,2-Dichloroethylene		NA	NC	NA	NC	NC	NA	NA	NC	NC	NA	NA	NC	NA	1.00E-02 p	1.00E-02	1.00E-02	NA	NA	NA	NA	NA	1.00E-02 r	1.00E-02
Ethylbenzene		1.10E-02	NC	--	1.10E-02	1.10E-02	2.50E-06	8.70E-03	NA	NA	--	NA	8.70E-03	1.00E-01	NA	1.00E-01	1.00E-01	2.00E+03	5.71E-01	1.00E+03	2.86E-01	NA	NA	5.71E-01
Isopropylbenzene		NA	NC	NA	NC	NC	NA	NA	NC	NC	NA	NA	NC	1.00E-01	NA	1.00E-01	1.00E-01	NA	NA	4.00E+02	1.14E-01	NA	NA	1.14E-01

TABLE C-1
TOXICITY CRITERIA FOR CHEMICALS OF POTENTIAL CONCERN
Former Pechiney Cast Plate, Inc. Facility
Vernon, California

Chemical	Surrogate	Carcinogenic Toxicity Criteria												Chronic Noncarcinogenic Toxicity Criteria									
		Oral				Dermal	Inhalation							Oral			Dermal	Inhalation					
		OEHHA CSFo[1]	U.S. EPA CSFo[2]	Other CSFo[3]	Final CSFo[4]	CSFd[5]	OEHHA URF[1]	OEHHA CSFi[6]	U.S. EPA URF[2]	U.S. EPA CSFi[6]	Other URF[3]	Other CSFi[6]	Final CSFi[4]	U.S. EPA RfDo[2]	Other RfDo[3]	Final RfDo[7]	RfDd[5]	OEHHA REL[1]	OEHHA RfDi[8]	U.S. EPA RfC[2]	U.S. EPA RfDi[8]	Other RfC[3]	Other RfDi[8]	Final RfDi[4]
		$(mg/kg\text{-}day)^{-1}$	$(mg/kg\text{-}day)^{-1}$	$(mg/kg\text{-}day)^{-1}$	$(mg/kg\text{-}day)^{-1}$	$(mg/kg\text{-}day)^{-1}$	$(\mu g/m^3)^{-1}$	$(mg/kg\text{-}day)^{-1}$	$(\mu g/m^3)^{-1}$	$(mg/kg\text{-}day)^{-1}$	$(\mu g/m^3)^{-1}$	$(mg/kg\text{-}day)^{-1}$	$(mg/kg\text{-}day)^{-1}$	(mg/kg-day)	(mg/kg-day)	(mg/kg-day)	(mg/kg-day)	$(\mu g/m^3)$	(mg/kg-day)	$(\mu g/m^3)$	(mg/kg-day)	$(\mu g/m^3)$	(mg/kg-day)	(mg/kg-day)
Isopropyltoluene	Isopropylbenzene	NA	NC	NA	NC	NC	NA	NA	NC	NC	NA	NA	NC	1.00E-01	NA	1.00E-01	1.00E-01	NA	NA	4.00E+02	1.14E-01	NA	NA	1.14E-01
Naphthalene		NA	NA	NA	NA	NA	3.40E-05	1.20E-01	NA	NA	--	NA	1.20E-01	2.00E-02	NA	2.00E-02	2.00E-02	9.00E+00	2.57E-03	3.00E+00	8.57E-04	NA	NA	2.57E-03
n-Propylbenzene		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4.00E-02 n	4.00E-02	4.00E-02	NA	NA	NA	NA	NA	4.00E-02 r	4.00E-02
Tetrachloroethylene (PCE)		5.40E-01	NA	--	5.40E-01	5.40E-01	5.90E-06	2.10E-02	NA	NA	--	NA	2.10E-02	1.00E-02	NA	1.00E-02	1.00E-02	3.50E+01	1.00E-02	NA	NA	2.70E+02 a	7.71E-02	1.00E-02
Toluene		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8.00E-02	NA	8.00E-02	8.00E-02	3.00E+02	8.57E-02	5.00E+03	1.43E+00	NA	NA	8.57E-02
1,1,1-Trichloroethane		NA	NC	NA	NC	NC	NA	NA	NC	NC	NA	NA	NC	2.00E+00	NA	2.00E+00	2.00E+00	NA	NA	5.00E+03	1.43E+00	NA	NA	1.43E+00
Trichloroethylene (TCE)		5.90E-03	NA	--	5.90E-03	5.90E-03	2.00E-06	7.00E-03	NA	NA	--	NA	7.00E-03	NA	3.00E-04 n	3.00E-04	3.00E-04	6.00E+02	1.71E-01	NA	NA	NA	NA	1.71E-01
1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene (oral reference dose)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.00E-02 p	5.00E-02	5.00E-02	NA	NA	NA	NA	7.00E+00 p	2.00E-03	2.00E-03
1,3,5-Trimethylbenzene		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.00E-02 p	5.00E-02	5.00E-02	NA	NA	NA	NA	6.00E+00 p	1.71E-03	1.71E-03
Total Xylenes		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.00E-01	--	2.00E-01	2.00E-01	7.00E+02	2.00E-01	1.00E+02	2.86E-02	NA	NA	2.00E-01
m,p-Xylenes	Xylenes (total)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.00E-01	--	2.00E-01	2.00E-01	7.00E+02	2.00E-01	1.00E+02	2.86E-02	NA	NA	2.00E-01
o-Xylene	Xylenes (total)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.00E-01	--	2.00E-01	2.00E-01	7.00E+02	2.00E-01	1.00E+02	2.86E-02	NA	NA	2.00E-01

Notes:
1. Office of Environmental Health Hazard Assessment (OEHHA), 2009, Toxicity Criteria Database; or OEHHA, 2008, Chronic Reference Exposure Levels.
2. U.S. EPA, 2009a, Integrated Risk Information System (IRIS) database.
3. Other U.S. EPA or U.S. Department of Health and Human Services toxicity criteria, as recommended or provided for specific chemicals in U.S. EPA, 2009b, Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites, April, or U.S. EPA, 2004c, Region IX Preliminary Remediation Goals (PRGs).
   Apportion Method and Worst-Case toxicity criteria for TPH mixtures calculated as described in Section 2.1 and Tables C-2 and C-3.
   a Toxicity value from ATSDR, as provided in U.S. EPA, 2009b, Regional Screening Levels
   h Toxicity value from HEAST, as provided in U.S. EPA, 2009b, Regional Screening Levels
   n Toxicity value from NCEA, as provided in U.S. EPA, 2004, Region 9 Preliminary Remediation Goals
   p PPRTV used as toxicity value, as provided in U.S. EPA, 2009b, Regional Screening Levels
   r Toxicity value derived via route-extrapolation, as recommended by DTSC (2009)

4. The final criteria is selected, in order, from OEHHA, IRIS, and then other U.S. EPA toxicity criteria sources.
5. In the derivation of dermal toxicity factors, gastrointestinal absorption efficiency was assumed to be 100 percent for all chemicals.
6. CSFi's calculated from URF's as follows: CSFi = (URF x 70 kg x 1000 µg/mg)/(20 m^3/day), unless provided by OEHHA Toxicity Criteria Database.
7. The final oral reference dose is selected, in order, from IRIS and then other U.S. EPA toxicity criteria sources.
8. RfDi's calculated from RfC's as follows: RfDi = RfC x (0.001 mg/µg) x (20 m^3/day)/(70 kg), unless route-extrapolated from an RfDo as indicated.

Abbreviations:
CSFd = dermal cancer slope factor
CSFi = inhalation cancer slope factor
CSFo = oral cancer slope factor
HEAST = Health Effects Assessment Summary Tables
mg/kg-day = milligrams per kilogram per day
µg/m^3 = micrograms per cubic meter
NA = not available
NC = noncarcinogenic
NCEA = National Center for Environmental Assessment
PPRTV = Provisional Peer-Reviewed Toxicity Value
RfC = reference concentration
RfDd = dermal reference dose
RfDi = inhalation reference dose
RfDo = oral reference dose
REL = reference exposure level
URF = unit risk factor
U.S. EPA = United States Environmental Protection Agency

References:

Department of Toxic Substances Control (DTSC), 2009, DTSC Recommended Methodology for Use of U.S. EPA Regional Screening Levels (RSLs) in HHRA risk assessment process at Department of Defense Sites and Facilities, Human and Ecological Risk Division, HHRA Note Number 3, May 6. Sacramento, California, June 16.
Office of Environmental Health Hazard Assessment (OEHHA), 2008, Chronic Reference Exposure Levels, December, <http://www.oehha.ca.gov/air/chronic_rels/AllChrels.html>.
OEHHA, 2009, OEHHA Toxicity Criteria Database, California Environmental Protection Agency, <http://www.oehha.ca.gov/risk/chemicaldata/index.asp>.
United States Environmental Protection Agency (U.S. EPA), 2004, Region IX Preliminary Remediation Goals (PRGs), October.
U.S. EPA, 2009a, Integrated Risk Information System (IRIS) on-line database, <http://www.epa.gov/iris>.
U.S. EPA, 2009b, Regional Screening Levels for Chemical Contaminants at Superfund Sites, Regions 3, 6, & 9, Oak Ridge National Laboratory, April, <http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm>.

TABLE C-2
APPORTION METHOD TOXICITY CRITERIA FOR TPH MIXTURES
Former Pechiney Cast Plate, Inc. Facility
Vernon, California

Hydrocarbon Range	DTSC-recommended Toxicity Criteria (2009) (RfD_x)		
	RfDo (mg/kg-day)	RfDi[1] (mg/kg-day)	RfC (µg/m3)
c5-c8 Aliphatics	0.04	0.2	700
c9-c18 Aliphatics	0.1	0.086	300
c19-c32 Aliphatics	2	--	--
c9-c16 Aromatics	0.004 [2]	0.014	50
c17-c32 Aromatics	0.03	--	--

Chemical	Carbon chains (total number of carbons [HC])[3]	Aliphatic/Aromatic Percentages (A_x)[4]		Percentages Estimated for Each Hydrocarbon Range (P_x)					Percent Sum (ΣP)	Normalized Percentages Estimated for Each Hydrocarbon Range (NP_x)[5]					**Final RfDo (mg/kg-day)**	**Final RfDi (mg/kg-day)**	**Final RfC (µg/m^3)**
		Aliphatics	Aromatics	C5-C8 Aliphatics	C9-C18 Aliphatics	C19-C32 Aliphatics	C9-C16 Aromatics	C17-C32 Aromatics		C5-C8 Aliphatics	C9-C18 Aliphatics	C19-C32 Aliphatics	C9-C16 Aromatics	C17-C32 Aromatics			
TPH as gasoline	c6 to c10 (5)	65%	35%	39%	26%	0%	14%	0%	79%	49%	33%	0%	18%	0%	**0.053**	**0.13**	**450**
TPH as diesel	c10 to c24 (15)	65%	35%	0%	39%	26%	16%	19%	100%	0%	39% / 70%	26% / 0%	16% / 30%	19% / 0%	**0.57**	**0.065**	**230**
TPH as motor oil	c23 to c40 (18)	75%	25%	0%	0%	42%	0%	14%	56%	0%	0%	75%	0%	25%	**1.51**	**--**	**--**
TPH as Stoddard solvent	c7 to c12 (6)	80%	20%	27%	53%	0%	13%	0%	93%	29%	57%	0%	14%	0%	**0.069**	**0.11**	**380**
TEPH (diesel and motor oil)	c10 to c40 (31)	70%	30%	0%	20%	32%	7%	15%	74%	0%	27% / 75%	43% / 0%	9% / 25%	21% / 0%	**0.89**	**0.068**	**240**
c6-c10 hydrocarbons	c6 to c10 (5)	65%	35%	39%	26%	0%	14%	0%	79%	49%	33%	0%	18%	0%	**0.053**	**0.13**	**450**
c10-c20 hydrocarbons	c10 to c20 (11)	65%	35%	0%	53%	12%	22%	13%	100%	0%	53% / 70%	12% / 0%	22% / 30%	13% / 0%	**0.29**	**0.065**	**230**
c10-c28 hydrocarbons	c10 to c28 (19)	65%	35%	0%	31%	34%	13%	22%	100%	0%	31% / 70%	34% / 0%	13% / 30%	22% / 0%	**0.72**	**0.065**	**230**
c21-c28 hydrocarbons	c21 to c28 (8)	65%	35%	0%	0%	65%	0%	35%	100%	0%	0%	65%	0%	35%	**1.31**	**--**	**--**

Equations:

$$P_x = \frac{HC_x}{HC} \times A \qquad NP_x = \frac{P_x}{\sum P_x} \qquad RfD = \sum (NP_x \times RfD_x)$$

See Section 2.1.1

Notes:
1. RfDi calculated from RfC as follows: RfDi = RfC x (0.001 mg/µg) x (20 m3/day)/(70 kg)
2. For sites at which naphthalene and the methylnaphthalenes have been evaluated individually, an RfD of 0.03 mg/kg-day can be used for c9-c16 aromatics per DTSC (2009). Naphthalene has been analyzed for at the Site, but not the methylnaphthalenes. RfDo of 0.004 mg/kg-day therefore used.
3. Carbon chain sizes associated with each non-discrete TPH mixture determined as follows:
   TPH as gasoline - c6 to c10; approximate composition based on information provided by ATSDR (1999) (c6 to c10-12) and U.S. EPA (1996) (c6 to c10)
   TPH as diesel - c10 to c24; approximate composition based on information provided by ATSDR (1999) (c8-12 to c24-26) and U.S. EPA (1996) (c10 to c28)
   TPH as motor oil - c23 to c40; approximate composition based on information provided by SFRWQCB (2008) (c24 to c40) and Curtis and Thompkins (2009)
   TPH as Stoddard solvent - c7 to c12; composition provided by ATSDR (1999)
   TEPH - c12 to c40; approximate composition based on information provided by Curtis and Thompkins (2009)
4. Aliphatic/aromatic percentages associated with each non-discrete TPH mixture determined as follows:
   TPH as gasoline - composition provided by ATSDR (1999): "...a general hydrocarbon distribution consisting of 4-8% alkanes, 2-5% alkenes, 25-40% isoalkanes, 3-7% cycloalkanes, 1-4% cycloalkenes, and 20-50% aromatics." Assumed 35% aromatic composition as a mid-point.
   TPH as diesel - composition provided by ATSDR (1999): "The composition consists of approximately 64% aliphatic hydrocarbons (straight chain alkanes and cycloalkanes), 1-2% unsaturated hydrocarbons (alkenes), and 35% aromatic hydrocarbons (including alkylbenzenes and 2-, 3-ring aromatics)."
   TPH as motor oil - No composition information provided by ATSDR (1999). Used composition information of diesel as surrogate.
   TPH as Stoddard solvent - composition provided by ATSDR (1999) - "Stoddard solvent consists of 30-50% linear and branched alkanes, 30-40% cycloalkanes, and 10-20% aromatic hydrocarbons." Assumed 80% aliphatic/20% aromatic to be conservative.
   TEPH - Based on the composition of diesel and motor oil.
   c6-c10, c10-c20, c10-c28, and c21-c28 hydrocarbons - Used composition information of gasoline or diesel (65% aliphatics, 35% aromatics) as surrogate.
5. A second set of normalized percentages was estimated for TPH as diesel, TEPH, c10-c20 hydrocarbons, and c10-c28 hydrocarbons for use in estimating their respective inhalation RfDs and RfCs to account for the low volatility/lack of inhalation toxicity criteria of the c19-c32 aliphatics and c17-c32 aromatics. The normalized percentages were re-calculated excluding these two groups.

Abbreviations:
RfC = reference concentration
RfDi = inhalation reference dose
RfDo = oral reference dose
TPH = total petroleum hydrocarbons
-- = Toxicity criteria not available or not developed due to low volatility of the hydrocarbons in the range or mixture. DTSC does not recommend performing a quantitative evaluation of inhalation exposure for c17+ hydrocarbons because of the significant uncertainty involved (DTSC, 2009).

References:

Agency for Toxic Substances Disease Registry (ATSDR), 1999, Toxicological Profile for Total Petroleum Hydrocarbons (TPH), U.S. Department of Health and Human Services, September.
Curtis and Thompkins, 2009, Phone Correspondence between Curtis and Thompkins Analytical Laboratory and AMEC Geomatrix, Inc. regarding composition of TPH.
Department of Toxic Substances Control (DTSC), 2009, Evaluating Human Health Risks from Total Petroleum Hydrocarbons (TPH), Interim Guidance, Human and Ecological Risk Division, California Department of Toxic Substances Control, Sacramento, California, June 16.
Regional Water Quality Control Board, San Francisco Bay Region (SFRWQCB), 2008, Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, Interim Final, Revised, May.
United States Environmental Protection Agency (U.S. EPA), 1996, Method 8015B, Nonhalogenated Organics Using GC/FID, Revision 2, December, http://www.accustandard.com/asi/pdfs/epa_methods/8015b.pdf.

TABLE C-3
WORST CASE TOXICITY CRITERIA FOR TPH MIXTURES
Former Pechiney Cast Plate, Inc. Facility
Vernon, California

Hydrocarbon Range	DTSC-recommended Toxicity Criteria (2009)		
	RfDo (mg/kg-day)	RfDi[1] (mg/kg-day)	RfC (µg/m3)
c5-c8 Aliphatics	0.04	0.2	700
c9-c18 Aliphatics	0.1	0.086	300
c19-c32 Aliphatics	2	--	--
c9-c16 Aromatics	0.004 [2]	0.014	50
c17-c32 Aromatics	0.03	--	--

Chemical	Carbon Chains[2]	Most Health-Protective RfD_o		Most Health-Protective RfD_i		Most Health-Protective RfC		**Final Toxicity Criteria (RfD or RfC)**		
		$RfD_{o,al}$ (mg/kg-day)	$RfD_{o,ar}$ (mg/kg-day)	$RfD_{i,al}$ (mg/kg-day)	$RfD_{i,ar}$ (mg/kg-day)	RfC_{al} (µg/m^3)	RfC_{ar} (µg/m^3)	**RfD_o (mg/kg-day)**	**RfD_i (mg/kg-day)**	**RfC (µg/m^3)**
TPH as gasoline	c6 to c10	0.04	0.004	0.086	0.014	300	50	**0.022**	**0.05**	**180**
TPH as diesel	c10 to c24	0.1	0.004	0.086	0.014	300	50	**0.052**	**0.05**	**180**
TPH as motor oil	c23 to c40	2	0.03	--	--	--	--	**1.02**	**--**	**--**
TPH as Stoddard solvent	c7 to c12	0.04	0.004	0.086	0.014	300	50	**0.022**	**0.05**	**180**
TEPH (diesel and motor oil)	c10 to c40	0.1	0.004	0.086	0.014	300	50	**0.052**	**0.05**	**180**
c6-c10 hydrocarbons	c6 to c10	0.04	0.004	0.086	0.014	300	50	**0.022**	**0.05**	**180**
c10-c20 hydrocarbons	c10 to c20	0.1	0.004	0.086	0.014	300	50	**0.052**	**0.05**	**180**
c10-c28 hydrocarbons	c10 to c28	0.1	0.004	0.086	0.014	300	50	**0.052**	**0.05**	**180**
c21-c28 hydrocarbons	c21 to c28	2	0.03	--	--	--	--	**1.02**	**--**	**--**

Notes:
1. RfDi calculated from RfC as follows: RfDi = RfC x (0.001 mg/µg) x (20 m3/day)/(70 kg)
2. For sites at which naphthalene and the methylnaphthalenes have been evaluated individually, an RfD of 0.03 mg/kg-day can be used for c9-c16 aromatics per DTSC (2009). Naphthalene has been analyzed for at the Site, but not the methylnaphthalenes. RfDo of 0.004 mg/kg-day therefore used.
3. Carbon chain groups associated with each non-discrete TPH mixture determined as described in Section 2.1.1 and Table C-2.

Equations:

$$RfD = (0.5 \times RfD_{al}) + (0.5 \times RfD_{ar})$$

See Section 2.1.2

Abbreviations:
RfC = reference concentration
RfDi = inhalation reference dose
RfDo = oral reference dose
TPH = total petroleum hydrocarbons
-- = Toxicity criteria not available or not developed due to low volatility of the hydrocarbons in the range or mixture. DTSC does not recommend performing a quantitative evaluation of inhalation exposure for c17+ hydrocarbons because of the significant uncertainty involved (DTSC, 2009).

References:
Department of Toxic Substances Control (DTSC), 2009, Evaluating Human Health Risks from Total Petroleum Hydrocarbons (TPH), Interim Guidance, Human and Ecological Risk Division, California Department of Toxic Substances Control, Sacramento, California, June 16.

TABLE C-4
PHYSICOCHEMICAL CONSTANTS FOR CHEMICALS OF POTENTIAL CONCERN
Former Pechiney Cast Plate, Inc. Facility
Vernon, California

Chemical	Log Octanol-Water Coefficient (log Kow) (unitless)	Ref	Henry's Law Constant (H) (atm-m^3/mole)	Ref	Diffusivity in Air (D_i) (cm^2/sec)	Ref	Diffusivity in Water (Dw) (cm^2/sec)	Ref	Organic Carbon Partition Coefficient (Koc) (L/kg)	Ref	Molecular Weight (MW) (g/mole)	Ref	Dermal Soil Absorption (ABSds) --	Ref
Polychlorinated Biphenyls (PCBs)														
Aroclor-1232	3.20	1	8.6E-04	1	NA	--	7.2E-06	1	6.8E+02	1	221	1	0.15	12
Aroclor-1248	6.06	1	2.9E-03	1	NA	--	6.6E-06	1	4.4E+05	1	288	1	0.15	12
Aroclor-1254	6.04	1	2.0E-03	5	1.6E-02	5	5.0E-06	5	2.0E+05	5	327	1	0.15	12
Aroclor-1260	6.51	1	1.9E-04	5	3.7E-02	5	5.3E-06	5	2.9E+05	5	370	1	0.15	12
Metals														
Arsenic	NA	--	NA	--	NA	--	NA	--	NA	--	75	4	0.04	2
Barium	NA	--	NA	--	NA	--	NA	--	NA	--	137	4	0.01	3
Beryllium	NA	--	NA	--	NA	--	NA	--	NA	--	9.01	4	0.01	3
Cadmium	NA	--	NA	--	NA	--	NA	--	NA	--	112	4	0.001	8
Chromium (total)	NA	--	NA	--	NA	--	NA	--	NA	--	52	4	0.01	3
Chromium VI	NA	--	NA	--	NA	--	NA	--	NA	--	52	4	0.01	3
Cobalt	NA	--	NA	--	NA	--	NA	--	NA	--	59	4	0.01	3
Copper	NA	--	NA	--	NA	--	NA	--	NA	--	64	4	0.01	3
Lead	NA	--	NA	--	NA	--	NA	--	NA	--	207.2	4	0.01	3
Mercury	NA	--	1.1E-02	6	3.1E-02	6	6.3E-06	6	5.2E+01	6	200.59	6	0.1	3
Molybdenum	NA	--	NA	--	NA	--	NA	--	NA	--	95.94	4	0.01	3
Nickel	NA	--	NA	--	NA	--	NA	--	NA	--	59	4	0.0002	2
Selenium	NA	--	NA	--	NA	--	NA	--	NA	--	79	4	0.01	3
Silver	NA	--	NA	--	NA	--	NA	--	NA	--	108	4	0.01	3
Thallium	NA	--	NA	--	NA	--	NA	--	NA	--	204	4	0.01	3
Vanadium	NA	--	NA	--	NA	--	NA	--	NA	--	51	4	0.01	3
Zinc	NA	--	NA	--	NA	--	NA	--	NA	--	65	4	0.01	3
Aliphatic and Aromatic Hydrocarbons														
c5-c8 Aliphatics	NA	--	8.0E-01	13	1.0E-01	13	1.0E-05	13	4.0E+03	13	NA	--	NA	--
c9-c18 Aliphatics	NA	--	1.9E+00	13	1.0E-01	13	1.0E-05	13	2.5E+05	13	NA	--	NA	--
c9-c16 Aromatics	NA	--	1.2E-02	13	1.0E-01	13	1.0E-05	13	2.5E+03	13	NA	--	NA	--
Volatile Organic Compounds (VOCs)														
Acetone	-0.24	10	3.9E-05	6	1.2E-01	6	1.1E-05	6	5.8E-01	6	58.08	6	0.1	3
Benzene	2.13	10	5.5E-03	6	8.8E-02	6	9.8E-06	6	5.9E+01	6	78.11	6	0.1	3
2-Butanone (MEK)	0.40	1	5.6E-05	10	8.1E-02	8	9.8E-06	6	2.3E+00	6	72.11	6	0.1	3
n-Butylbenzene	4.35	1	1.3E-02	6	5.7E-02	6	8.1E-06	6	1.1E+03	6	134.22	6	0.1	3
sec-Butylbenzene	4.24	1	1.4E-02	6	5.7E-02	6	8.1E-06	6	9.7E+02	6	134.22	6	0.1	3
Carbon Tetrachloride	2.73	3	3.0E-02	10	7.8E-02	8	8.8E-06	6	1.7E+02	6	153.82	6	0.1	3
Chloroform	1.92	10	3.7E-03	6	1.0E-01	6	1.0E-05	6	4.0E+01	6	119.38	6	0.1	3
1,2-Dichloroethane (EDC)	1.47	3	9.8E-04	10	1.0E-01	8	9.9E-06	6	1.7E+01	6	98.96	6	0.1	3
1,1-Dichloroethylene	2.13	10	2.6E-02	6	9.0E-02	6	1.0E-05	6	5.9E+01	6	96.94	6	0.1	3
cis-1,2-Dichloroethylene	1.86	3	4.1E-03	10	7.4E-02	8	1.1E-05	8	3.6E+01	8	96.94	8	0.1	3
Ethylbenzene	3.14	10	7.9E-03	6	7.5E-02	6	7.8E-06	6	3.6E+02	6	106.17	6	0.1	3
Isopropylbenzene	3.60	1	1.2E+00	6	6.5E-02	6	7.1E-06	6	4.9E+02	6	120.19	6	0.1	3
Isopropyltoluene	4.10	7	1.1E-02	11	5.6E-02	7	7.3E-06	7	4.1E+03	11	134.22	4	0.1	3
Naphthalene	3.36	10	4.8E-04	6	5.9E-02	6	7.5E-06	6	2.0E+03	6	128.18	6	0.1	3
n-Propylbenzene	3.62	1	1.1E-02	6	6.0E-02	6	7.8E-06	6	5.6E+02	6	120.19	6	0.1	3
Tetrachloroethylene (PCE)	2.67	10	1.8E-02	6	7.2E-02	6	8.2E-06	6	1.6E+02	6	165.83	6	0.1	3

TABLE C-4
PHYSICOCHEMICAL CONSTANTS FOR CHEMICALS OF POTENTIAL CONCERN
Former Pechiney Cast Plate, Inc. Facility
Vernon, California

Chemical	Log Octanol-Water Coefficient (log Kow) (unitless)	Ref	Henry's Law Constant (H) (atm-m^3/mole)	Ref	Diffusivity in Air (D_i) (cm^2/sec)	Ref	Diffusivity in Water (Dw) (cm^2/sec)	Ref	Organic Carbon Partition Coefficient (Koc) (L/kg)	Ref	Molecular Weight (MW) (g/mole)	Ref	Dermal Soil Absorption (ABSds) --	Ref
Toluene	2.75	10	6.6E-03	6	8.7E-02	6	8.6E-06	6	1.8E+02	6	92.14	6	0.1	3
1,1,1-Trichloroethane	2.48	10	1.7E-02	6	7.8E-02	6	8.8E-06	6	1.1E+02	6	133.4	6	0.1	3
Trichloroethylene (TCE)	2.71	10	1.0E-02	6	7.9E-02	6	9.1E-06	6	1.7E+02	6	131.39	6	0.1	3
1,2,4-Trimethylbenzene	3.72	1	6.1E-03	6	6.1E-02	6	7.9E-06	6	1.4E+03	6	120.2	6	0.1	3
1,3,5-Trimethylbenzene	3.54	1	5.9E-03	6	6.0E-02	6	8.7E-06	6	1.4E+03	6	120.2	6	0.1	3
Total Xylenes	3.17	10	7.3E-03	9	7.0E-02	9	7.9E-06	9	2.0E+02	9	106.17	9	0.1	3
m,p-Xylenes	3.20	1	7.6E-03	6	7.7E-02	6	8.4E-06	6	3.9E+02	6	106.17	6	0.1	3
o-Xylene	3.13	1	5.2E-03	6	8.7E-02	6	1.0E-05	6	3.6E+02	6	106.17	6	0.1	3

Notes:

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Abbreviations:

atm-m^3/mole = atmospheres - cubic meter per mole
cm^2/sec = square centimeters per second
g/mole = grams per mole
L/kg = liters per kilogram
NA = not available
Ref = reference
-- = not applicable

TABLE C-5

EXPOSURE PARAMETERS USED IN DEVELOPING RISK-BASED SCREENING LEVELS FOR OUTDOOR COMMERCIAL/INDUSTRIAL WORKERS

Former Pechiney Cast Plate, Inc. Facility
Vernon, California

Exposure Parameter	Units	Value
GENERAL EXPOSURE PARAMETERS		
Exposure Frequency (EF)	days/year	250
Exposure Duration (ED)	years	25
Body Weight (BW)	kg	70
Averaging Time (AT)	days	25,550 (carcinogens) 9,125 (noncarcinogens)
PATHWAY-SPECIFIC PARAMETERS		
Incidental Soil Ingestion		
Soil Ingestion Rate (IR_s)	mg/day	100
Dermal Contact with Soil		
Exposed Skin Surface Area (SA_s)	cm^2/day	5,700
Soil-to-Skin Adherence Factor (SAF)	mg/cm^2	0.2
Absorption Fraction (ABSds)	unitless	Chemical-specific (see Table C-4)
Inhalation of Suspended Soil Particulates		
Inhalation Rate (IHR_a)	m^3/day	14 (over an 8 hour workday)
Particulate Emission Factor (PEF)	m^3/kg	$1.32x10^9$
Inhalation of Vapors in Outdoor Air		
Inhalation Rate (IHR_a)	m^3/day	14 (over an 8 hour workday)

Abbreviations:
cm^2/day = centimeters squared per day
kg = kilograms
m^3/day = cubic meters per day
m^3/kg = cubic meters per kilogram
mg/cm^2 = milligrams per squared centimeters
mg/day = milligrams per day

TABLE C-6

EXPOSURE PARAMETERS USED IN DEVELOPING RISK-BASED SCREENING LEVELS FOR CONSTRUCTION WORKERS

Former Pechiney Cast Plate, Inc. Facility
Vernon, California

Exposure Parameter	Units	Value
GENERAL EXPOSURE PARAMETERS		
Exposure Frequency (EF)	days/year	250
Exposure Duration (ED)	years	1
Body Weight (BW)	kg	70
Averaging Time (AT)	days	25,550 (carcinogens) 365 (noncarcinogens)
Pathway-Specific Parameters		
Incidental Soil Ingestion		
Soil Ingestion Rate (IR_s)	mg/day	330
Dermal Contact with Soil		
Exposed Skin Surface Area (SA_s)	cm^2/day	5,700
Soil-to-Skin Adherence Factor (SAF)	mg/cm^2	0.8
Absorption Fraction (ABSds)	unitless	Chemical-specific (see Table C-4)
Inhalation of Vapors in Ambient Air		
Inhalation Rate (IHR_a)	m^3/day	20 (over an 8 hour workday)
Inhalation of Suspended Soil Particulates		
Particulate Emission Factor (PEF)	m^3/kg	$1.0x10^6$
Inhalation Rate (IHR_a)	m^3/day	20 (over an 8 hour workday)

Abbreviations:
cm^2/day = centimeters squared per day
kg = kilograms
m^3/day = cubic meters per day
m^3/kg = cubic meters per kilogram
mg/cm^2 = milligrams per squared centimeters
mg/day = milligrams per day

TABLE C-7
RISK-BASED SCREENING LEVELS FOR CHEMICALS OF POTENTIAL CONCERN IN SOIL --
OUTDOOR COMMERCIAL/INDUSTRIAL WORKER
Former Pechiney Cast Plate, Inc. Facility
Vernon, California

Chemical	Oral Cancer Slope Factor (CSF_o) $(mg/kg\text{-}day)^{-1}$	Dermal Cancer Slope Factor (CSFd) $(mg/kg\text{-}day)^{-1}$	Inhalation Cancer Slope Factor (CSF_i) $(mg/kg\text{-}day)^{-1}$	Oral Reference Dose (RfDo) (mg/kg-day)	Dermal Reference Dose (RfDd) (mg/kg-day)	Inhalation Reference Dose (RfDi) (mg/kg-day)	Absorption Factor ABS (--)	Molecular Weight (g/mole)	Henry's Law Constant (atm-m^3/mole)	VOC? [2]	Soil RBSL[1] -- Outdoor Commercial/Industrial	
											Cancer (mg/kg)	Noncancer (mg/kg)
Polychlorinated Biphenyls (PCBs)												
Aroclor-1232	2	2	2	NA	NA	NA	0.15	2.2E+02	8.6E-04	No	5.3E-01	--
Aroclor-1248	2	2	2	NA	NA	NA	0.15	2.9E+02	2.9E-03	No	5.3E-01	--
Aroclor-1254	2	2	2	2.00E-05	2.00E-05	2.00E-05	0.15	3.3E+02	2.0E-03	No	5.3E-01	7.5E+00
Aroclor-1260	2	2	2	NA	NA	NA	0.15	3.7E+02	1.9E-04	No	5.3E-01	--
Metals												
Arsenic	1.5	1.5	12	3.00E-04	3.00E-04	4.29E-06	0.04	7.5E+01	NA	No	1.3E+00	2.1E+02
Barium	NC	NC	NC	2.00E-01	2.00E-01	1.43E-04	0.01	1.4E+02	NA	No	NC	1.6E+05
Cadmium	NA	NA	15	5.00E-04	5.00E-04	5.71E-06	0.001	1.1E+02	NA	No	1.8E+03	5.0E+02
Chromium (total)	NA	NA	42	1.50E+00	1.50E+00	1.50E+00	0.01	5.2E+01	NA	No	6.4E+02	1.4E+06
Cobalt	NA	NA	31.5	3.00E-04	3.00E-04	1.71E-06	0.01	5.9E+01	NA	No	8.5E+02	2.7E+02
Copper	NC	NC	NC	4.00E-02	4.00E-02	3.70E-02	0.01	6.4E+01	NA	No	NC	3.7E+04
Mercury	NA	NA	NA	3.00E-04	3.00E-04	8.57E-06	0.1	2.0E+02	1.1E-02	No	--	1.4E+02
Molybdenum	NA	NA	NA	5.00E-03	5.00E-03	5.00E-03	0.01	9.6E+01	NA	No	--	4.6E+03
Nickel	NA	NA	0.91	2.00E-02	2.00E-02	1.43E-05	0.0002	5.9E+01	NA	No	3.0E+04	1.8E+04
Silver	NC	NC	NC	5.00E-03	5.00E-03	5.00E-03	0.01	1.1E+02	NA	No	NC	4.6E+03
Thallium	NA	NA	NA	6.50E-05	6.50E-05	8.00E-05	0.01	2.0E+02	NA	No	--	6.0E+01
Vanadium	NA	NA	NA	7.00E-03	7.00E-03	7.00E-03	0.01	5.1E+01	NA	No	--	6.4E+03
Zinc	NC	NC	NC	3.00E-01	3.00E-01	3.00E-01	0.01	6.5E+01	NA	No	NC	2.8E+05
Total Petroleum Hydrocarbons (Apportion Method)												
TPH as gasoline	NA	NA	NA	5.30E-02	5.30E-02	1.30E-01	0.1	NA	NA	Yes	--	2.5E+04
TPH as diesel	NA	NA	NA	5.70E-01	5.70E-01	6.50E-02	0.1	NA	NA	No	--	2.7E+05
TPH as motor oil	NA	NA	NA	1.51E+00	1.51E+00	NA	0.1	NA	NA	No	--	7.2E+05
TPH as Stoddard solvent	NA	NA	NA	6.90E-02	6.90E-02	1.10E-01	0.1	NA	NA	Yes	--	3.3E+04
TEPH	NA	NA	NA	8.90E-01	8.90E-01	6.80E-02	0.1	NA	NA	No	--	4.2E+05
c6-c10 hydrocarbons	NA	NA	NA	5.30E-02	5.30E-02	1.30E-01	0.1	NA	NA	Yes	--	2.5E+04
c10-c20 hydrocarbons	NA	NA	NA	2.90E-01	2.90E-01	6.50E-02	0.1	NA	NA	No	--	1.4E+05
c10-c28 hydrocarbons	NA	NA	NA	7.20E-01	7.20E-01	6.50E-02	0.1	NA	NA	No	--	3.4E+05
c21-c28 hydrocarbons	NA	NA	NA	1.31E+00	1.31E+00	NA	0.1	NA	NA	No	--	6.3E+05
Total Petroleum Hydrocarbons (Worst Case)												
TPH as gasoline	NA	NA	NA	2.20E-02	2.20E-02	5.00E-02	0.1	NA	NA	Yes	--	1.1E+04
TPH as diesel	NA	NA	NA	5.20E-02	5.20E-02	5.00E-02	0.1	NA	NA	No	--	2.5E+04
TPH as motor oil	NA	NA	NA	1.02E+00	1.02E+00	NA	0.1	NA	NA	No	--	4.9E+05
TPH as Stoddard solvent	NA	NA	NA	2.20E-02	2.20E-02	5.00E-02	0.1	NA	NA	Yes	--	1.1E+04
TEPH	NA	NA	NA	5.20E-02	5.20E-02	5.00E-02	0.1	NA	NA	No	--	2.5E+04
c6-c10 hydrocarbons	NA	NA	NA	2.20E-02	2.20E-02	5.00E-02	0.1	NA	NA	Yes	--	1.1E+04
c10-c20 hydrocarbons	NA	NA	NA	5.20E-02	5.20E-02	5.00E-02	0.1	NA	NA	No	--	2.5E+04
c10-c28 hydrocarbons	NA	NA	NA	5.20E-02	5.20E-02	5.00E-02	0.1	NA	NA	No	--	2.5E+04
c21-c28 hydrocarbons	NA	NA	NA	1.02E+00	1.02E+00	NA	0.1	NA	NA	No	--	4.9E+05
Volatile Organic Compounds (VOCs) [3]												
Acetone	NA	NA	NA	9.00E-01	9.00E-01	8.86E+00	0.1	5.8E+01	3.9E-05	Yes	--	4.3E+05
Benzene	0.1	0.1	0.1	4.00E-03	4.00E-03	1.71E-02	0.1	7.8E+01	5.5E-03	Yes	1.3E+01	1.9E+03
n-Butylbenzene	NA	NA	NA	4.00E-02	4.00E-02	4.00E-02	0.1	1.3E+02	1.3E-02	Yes	--	1.9E+04
sec-Butylbenzene	NA	NA	NA	4.00E-02	4.00E-02	4.00E-02	0.1	1.3E+02	1.4E-02	Yes	--	1.9E+04
Ethylbenzene	0.011	0.011	0.0087	1.00E-01	1.00E-01	5.71E-01	0.1	1.1E+02	7.9E-03	Yes	1.2E+02	4.8E+04
Isopropylbenzene	NC	NC	NC	1.00E-01	1.00E-01	1.14E-01	0.1	1.2E+02	1.2E+00	Yes	NC	4.8E+04
Isopropyltoluene	NC	NC	NC	1.00E-01	1.00E-01	1.14E-01	0.1	1.3E+02	1.1E-02	Yes	NC	4.8E+04
Naphthalene	NA	NA	0.12	2.00E-02	2.00E-02	2.57E-03	0.1	1.3E+02	4.8E-04	Yes	--	9.6E+03
n-Propylbenzene	NA	NA	NA	4.00E-02	4.00E-02	4.00E-02	0.1	1.2E+02	1.1E-02	Yes	--	1.9E+04
Tetrachloroethylene (PCE)	0.54	0.54	0.021	1.00E-02	1.00E-02	1.00E-02	0.1	1.7E+02	1.8E-02	Yes	2.5E+00	4.8E+03
Toluene	NA	NA	NA	8.00E-02	8.00E-02	8.57E-02	0.1	9.2E+01	6.6E-03	Yes	--	3.8E+04
Trichloroethylene (TCE)	0.0059	0.0059	0.007	3.00E-04	3.00E-04	1.71E-01	0.1	1.3E+02	1.0E-02	Yes	2.3E+02	1.4E+02
1,2,4-Trimethylbenzene	NA	NA	NA	5.00E-02	5.00E-02	2.00E-03	0.1	1.2E+02	6.1E-03	Yes	--	2.4E+04
1,3,5-Trimethylbenzene	NA	NA	NA	5.00E-02	5.00E-02	1.71E-03	0.1	1.2E+02	5.9E-03	Yes	--	2.4E+04
Total Xylenes	NA	NA	NA	2.00E-01	2.00E-01	2.00E-01	0.1	1.1E+02	7.3E-03	Yes	--	9.6E+04
m/p-Xylenes	NA	NA	NA	2.00E-01	2.00E-01	2.00E-01	0.1	1.1E+02	7.6E-03	Yes	--	9.6E+04
o-Xylene	NA	NA	NA	2.00E-01	2.00E-01	2.00E-01	0.1	1.1E+02	5.2E-03	Yes	--	9.6E+04

Notes:

1. Risk-based screening levels (RBSL) calculated using the methodology presented by OEHHA, 2005, Human-Exposed-Based Screening Numbers Developed to Aid Estimation of Cleanup Costs for Contaminated Soil, January.
2. Chemicals identified as a volatile organic compound (VOC) if the molecular weight is less than 200 g/mole and the Henry's Law Constant is greater than $1x10^{-5}$ atm-m^3/mole. Volatile TPH identified on the basis of analytical methods for the TPH mixture in soil vapor. The inhalation pathway is not evaluated in the RBSL for VOCs in soil. A particulate emission factor (PEF) of $1.316x10^9$ m^3/kg is used in the derivation of RBSLs for all non-volatile chemicals.
3. Inhalation pathway not incorporated into the development of soil RBSLs for VOCs. Volatilization of chemicals from the subsurface to ambient air evaluated using RBSLs developed for soil vapor (Table C-12).

Abbreviations:

atm-m^3/mole = atmospheres - cubic meter per mole
g/mole = grams per mole
mg/kg = milligrams per kilogram
mg/kg-day = milligrams per kilogram - day
NA = not available
NC = noncarcinogenic
-- = not applicable

Equations:

$$RBSL_{soil-risk} = \frac{TR \times BW \times AT_{ca}}{ED \times EF \times \left[\left(\frac{IR_s \times CSF_o}{CF_{kg-mg}}\right) + \left(\frac{SAs \times SAF \times ABS \times CSF_o}{CF_{kg-mg}}\right) + \left(\frac{IHR_a \times CSF_i}{PEF}\right)\right]}$$

$$RBSL_{soil-haz} = \frac{THQ \times BW \times AT_{nc}}{ED \times EF \times \left[\left(\frac{1}{RfD_o} \times \frac{IR_s}{CF_{kg-mg}}\right) + \left(\frac{1}{RfD_o} \times \frac{SAs \times SAF \times ABS}{CF_{kg-mg}}\right) + \left(\frac{1}{RfD_i} \times \frac{IHR_a}{PEF}\right)\right]}$$

See Section 3.1

TABLE C-8
RISK-BASED SCREENING LEVELS FOR CHEMICALS OF POTENTIAL CONCERN IN SOIL --
CONSTRUCTION WORKER
Former Pechiney Cast Plate, Inc. Facility
Vernon, California

Chemical	Oral Cancer Slope Factor (CSF_o) $(mg/kg\text{-}day)^{-1}$	Dermal Cancer Slope Factor (CSFd) $(mg/kg\text{-}day)^{-1}$	Inhalation Cancer Slope Factor (CSF_i) $(mg/kg\text{-}day)^{-1}$	Oral Reference Dose (RfDo) (mg/kg-day)	Dermal Reference Dose (RfDd) (mg/kg-day)	Inhalation Reference Dose (RfDi) (mg/kg-day)	Absorption Factor ABS (--)	Molecular Weight (g/mole)	Henry's Law Constant (atm-m^3/mole)	VOC? [2]	Soil RBSL[1] -- Construction Worker	
											Cancer (mg/kg)	Noncancer (mg/kg)
Polychlorinated Biphenyls (PCBs)												
Aroclor-1232	2	2	2	NA	NA	NA	0.15	2.2E+02	8.6E-04	No	3.5E+00	--
Aroclor-1248	2	2	2	NA	NA	NA	0.15	2.9E+02	2.9E-03	No	3.5E+00	--
Aroclor-1254	2	2	2	2.00E-05	2.00E-05	2.00E-05	0.15	3.3E+02	2.0E-03	No	3.5E+00	2.0E+00
Aroclor-1260	2	2	2	NA	NA	NA	0.15	3.7E+02	1.9E-04	No	3.5E+00	--
Metals												
Arsenic	1.5	1.5	12	3.00E-04	3.00E-04	4.29E-06	0.04	7.5E+01	NA	No	7.1E+00	1.6E+01
Barium	NC	NC	NC	2.00E-01	2.00E-01	1.43E-04	0.01	1.4E+02	NA	No	NC	7.2E+02
Cadmium	NA	NA	15	5.00E-04	5.00E-04	5.71E-06	0.001	1.1E+02	NA	No	2.4E+01	2.5E+01
Chromium (total)	NA	NA	42	1.50E+00	1.50E+00	1.50E+00	0.01	5.2E+01	NA	No	8.5E+00	3.9E+05
Cobalt	NA	NA	31.5	3.00E-04	3.00E-04	1.71E-06	0.01	5.9E+01	NA	No	1.1E+01	7.9E+00
Copper	NC	NC	NC	4.00E-02	4.00E-02	3.70E-02	0.01	6.4E+01	NA	No	NC	1.0E+04
Mercury	NA	NA	NA	3.00E-04	3.00E-04	8.57E-06	0.1	2.0E+02	1.1E-02	No	--	2.1E+01
Molybdenum	NA	NA	NA	5.00E-03	5.00E-03	5.00E-03	0.01	9.6E+01	NA	No	--	1.3E+03
Nickel	NA	NA	0.91	2.00E-02	2.00E-02	1.43E-05	0.0002	5.9E+01	NA	No	3.9E+02	7.2E+01
Silver	NC	NC	NC	5.00E-03	5.00E-03	5.00E-03	0.01	1.1E+02	NA	No	NC	1.3E+03
Thallium	NA	NA	NA	6.50E-05	6.50E-05	8.00E-05	0.01	2.0E+02	NA	No	--	1.7E+01
Vanadium	NA	NA	NA	7.00E-03	7.00E-03	7.00E-03	0.01	5.1E+01	NA	No	--	1.8E+03
Zinc	NC	NC	NC	3.00E-01	3.00E-01	3.00E-01	0.01	6.5E+01	NA	No	NC	7.8E+04
Total Petroleum Hydrocarbons (Apportion Method)												
TPH as gasoline	NA	NA	NA	5.30E-02	5.30E-02	1.30E-01	0.1	NA	NA	Yes	--	6.9E+03
TPH as diesel	NA	NA	NA	5.70E-01	5.70E-01	6.50E-02	0.1	NA	NA	No	--	6.1E+04
TPH as motor oil	NA	NA	NA	1.51E+00	1.51E+00	NA	0.1	NA	NA	No	--	2.0E+05
TPH as Stoddard solvent	NA	NA	NA	6.90E-02	6.90E-02	1.10E-01	0.1	NA	NA	Yes	--	9.0E+03
TEPH	NA	NA	NA	8.90E-01	8.90E-01	6.80E-02	0.1	NA	NA	No	--	8.7E+04
c6-c10 hydrocarbons	NA	NA	NA	5.30E-02	5.30E-02	1.30E-01	0.1	NA	NA	Yes	--	6.9E+03
c10-c20 hydrocarbons	NA	NA	NA	2.90E-01	2.90E-01	6.50E-02	0.1	NA	NA	No	--	3.4E+04
c10-c28 hydrocarbons	NA	NA	NA	7.20E-01	7.20E-01	6.50E-02	0.1	NA	NA	No	--	7.3E+04
c21-c28 hydrocarbons	NA	NA	NA	1.31E+00	1.31E+00	NA	0.1	NA	NA	No	--	1.7E+05
Total Petroleum Hydrocarbons (Worst Case)												
TPH as gasoline	NA	NA	NA	2.20E-02	2.20E-02	5.00E-02	0.1	NA	NA	Yes	--	2.9E+03
TPH as diesel	NA	NA	NA	5.20E-02	5.20E-02	5.00E-02	0.1	NA	NA	No	--	6.6E+03
TPH as motor oil	NA	NA	NA	1.02E+00	1.02E+00	NA	0.1	NA	NA	No	--	1.3E+05
TPH as Stoddard solvent	NA	NA	NA	2.20E-02	2.20E-02	5.00E-02	0.1	NA	NA	Yes	--	2.9E+03
TEPH	NA	NA	NA	5.20E-02	5.20E-02	5.00E-02	0.1	NA	NA	No	--	6.6E+03
c6-c10 hydrocarbons	NA	NA	NA	2.20E-02	2.20E-02	5.00E-02	0.1	NA	NA	Yes	--	2.9E+03
c10-c20 hydrocarbons	NA	NA	NA	5.20E-02	5.20E-02	5.00E-02	0.1	NA	NA	No	--	6.6E+03
c10-c28 hydrocarbons	NA	NA	NA	5.20E-02	5.20E-02	5.00E-02	0.1	NA	NA	No	--	6.6E+03
c21-c28 hydrocarbons	NA	NA	NA	1.02E+00	1.02E+00	NA	0.1	NA	NA	No	--	1.3E+05

TABLE C-8
RISK-BASED SCREENING LEVELS FOR CHEMICALS OF POTENTIAL CONCERN IN SOIL -- CONSTRUCTION WORKER
Former Pechiney Cast Plate, Inc. Facility
Vernon, California

Chemical	Oral Cancer Slope Factor (CSF_o) (mg/kg-day)$^{-1}$	Dermal Cancer Slope Factor (CSFd) (mg/kg-day)$^{-1}$	Inhalation Cancer Slope Factor (CSF_i) (mg/kg-day)$^{-1}$	Oral Reference Dose (RfDo) (mg/kg-day)	Dermal Reference Dose (RfDd) (mg/kg-day)	Inhalation Reference Dose (RfDi) (mg/kg-day)	Absorption Factor ABS (--)	Molecular Weight (g/mole)	Henry's Law Constant (atm-m^3/mole)	VOC? [2]	Soil RBSL[1] -- Construction Worker	
											Cancer (mg/kg)	Noncancer (mg/kg)
Volatile Organic Compounds (VOCs) [3]												
Acetone	NA	NA	NA	9.00E-01	9.00E-01	8.86E+00	0.1	5.8E+01	3.9E-05	Yes	--	1.2E+05
Benzene	0.1	0.1	0.1	4.00E-03	4.00E-03	1.71E-02	0.1	7.8E+01	5.5E-03	Yes	9.1E+01	5.2E+02
n-Butylbenzene	NA	NA	NA	4.00E-02	4.00E-02	4.00E-02	0.1	1.3E+02	1.3E-02	Yes	--	5.2E+03
sec-Butylbenzene	NA	NA	NA	4.00E-02	4.00E-02	4.00E-02	0.1	1.3E+02	1.4E-02	Yes	--	5.2E+03
Ethylbenzene	0.011	0.011	0.0087	1.00E-01	1.00E-01	5.71E-01	0.1	1.1E+02	7.9E-03	Yes	8.3E+02	1.3E+04
Isopropylbenzene	NC	NC	NC	1.00E-01	1.00E-01	1.14E-01	0.1	1.2E+02	1.2E+00	Yes	NC	1.3E+04
Isopropyltoluene	NC	NC	NC	1.00E-01	1.00E-01	1.14E-01	0.1	1.3E+02	1.1E-02	Yes	NC	1.3E+04
Naphthalene	NA	NA	0.12	2.00E-02	2.00E-02	2.57E-03	0.1	1.3E+02	4.8E-04	Yes	--	2.6E+03
n-Propylbenzene	NA	NA	NA	4.00E-02	4.00E-02	4.00E-02	0.1	1.2E+02	1.1E-02	Yes	--	5.2E+03
Tetrachloroethylene (PCE)	0.54	0.54	0.021	1.00E-02	1.00E-02	1.00E-02	0.1	1.7E+02	1.8E-02	Yes	1.7E+01	1.3E+03
Toluene	NA	NA	NA	8.00E-02	8.00E-02	8.57E-02	0.1	9.2E+01	6.6E-03	Yes	--	1.0E+04
Trichloroethylene (TCE)	0.0059	0.0059	0.007	3.00E-04	3.00E-04	1.71E-01	0.1	1.3E+02	1.0E-02	Yes	1.5E+03	3.9E+01
1,2,4-Trimethylbenzene	NA	NA	NA	5.00E-02	5.00E-02	2.00E-03	0.1	1.2E+02	6.1E-03	Yes	--	6.5E+03
1,3,5-Trimethylbenzene	NA	NA	NA	5.00E-02	5.00E-02	1.71E-03	0.1	1.2E+02	5.9E-03	Yes	--	6.5E+03
Total Xylenes	NA	NA	NA	2.00E-01	2.00E-01	2.00E-01	0.1	1.1E+02	7.3E-03	Yes	--	2.6E+04
m/p-Xylenes	NA	NA	NA	2.00E-01	2.00E-01	2.00E-01	0.1	1.1E+02	7.6E-03	Yes	--	2.6E+04
o-Xylene	NA	NA	NA	2.00E-01	2.00E-01	2.00E-01	0.1	1.1E+02	5.2E-03	Yes	--	2.6E+04

Notes:
1. Risk-based screening levels (RBSL) calculated using the methodology presented by OEHHA, 2005, Human-Exposed-Based Screening Numbers Developed to Aid Estimation of Cleanup Costs for Contaminated Soil, January.
2. Chemicals identified as a volatile organic compound (VOC) if the molecular weight is less than 200 g/mole and the Henry's Law Constant is greater than 1x10 $^{-5}$ atm-m^3/mole. Volatile TPH identified on the basis of analytical methods for the TPH mixture in soil vapor. The inhalation pathway is not evaluated in the RBSL for VOCs in soil. A particulate emission factor (PEF) of 2.0x10 ^{7} m^3/kg is used in the derivation of RBSLs for all non-volatile chemicals.
3. Inhalation pathway not incorporated into the development of soil RBSLs for VOCs. Volatilization of chemicals from the subsurface to ambient air evaluated using RBSLs developed for soil vapor (Table C-13).

Abbreviations:
atm-m^3/mole = atmospheres - cubic meter per mole
g/mole = grams per mole
mg/kg = milligrams per kilogram
mg/kg-day = milligrams per kilogram - day
NA = not available
NC = noncarcinogenic
-- = not applicable

Equations:

$$RBSL_{soil-risk} = \frac{TR \times BW \times AT_{ca}}{ED \times EF \times \left[\left(\frac{IR_s \times CSF_o}{CF_{kg-mg}}\right) + \left(\frac{SAs \times SAF \times ABS \times CSF_o}{CF_{kg-mg}}\right) + \left(\frac{IHR_a \times CSF_i}{PEF}\right)\right]}$$

$$RBSL_{soil-haz} = \frac{THQ \times BW \times AT_{nc}}{ED \times EF \times \left[\left(\frac{1}{RfD_o} \times \frac{IR_s}{CF_{kg-mg}}\right) + \left(\frac{1}{RfD_o} \times \frac{SAs \times SAF \times ABS}{CF_{kg-mg}}\right) + \left(\frac{1}{RfD_i} \times \frac{IHR_a}{PEF}\right)\right]}$$

See Section 3.1

TABLE C-9
HEALTH-BASED SCREENING LEVELS FOR LEAD IN SOIL
Former Pechiney Cast Plate, Inc. Facility
Vernon, California

Exposure Scenario	Screening Level[1] (mg/kg)
Outdoor Commercial/Industrial Worker	320
Construction Worker	940

Notes:

1. Health-based screening levels derived using either the U.S. EPA Adult Lead Model (U.S. EPA, 2005) (for commercial/industrial workers) or DTSC's Leadspread (1999) (for construction workers), as described in Section 3.2 and presented in Attachments B-1 and B-2.

Abbreviations:

mg/kg = milligrams per kilogram

TABLE C-10

EXPOSURE PARAMETERS USED IN DEVELOPING RISK-BASED SCREENING LEVELS FOR INDOOR COMMERCIAL/INDUSTRIAL WORKERS

Former Pechiney Cast Plate, Inc. Facility
Vernon, California

Exposure Parameter	Units	Value
GENERAL EXPOSURE PARAMETERS		
Exposure Frequency (EF)	days/year	250
Exposure Duration (ED)	years	25
Body Weight (BW)	kg	70
Averaging Time (AT)	days	25,550 (carcinogens) 9,125 (noncarcinogens)
PATHWAY-SPECIFIC PARAMETERS		
Inhalation of Vapors in Indoor Air		
Inhalation Rate (IHR_a)	m^3/day	14 (over an 8 hour workday)

Abbreviations:
kg = kilograms
m^3/day = cubic meters per day

TABLE C-11
RISK-BASED SCREENING LEVELS FOR SOIL VAPOR --
INDOOR COMMERCIAL/INDUSTRIAL WORKER
Former Pechiney Cast Plate, Inc. Facility
Vernon, California

Chemical	Inhalation Toxicity Criteria		Soil Vapor RBSL -- Indoor Commercial/Industrial Worker					
			Cancer			Noncancer		
	Cancer Slope Factor (CSF_i) $(mg/kg\text{-}day)^{-1}$	Reference Dose (RfD_i) (mg/kg-day)	Indoor Air ($\mu g/m^3$)	alpha[2] (unitless)	Soil Vapor (µg/L)	Indoor Air ($\mu g/m^3$)	alpha[2] (unitless)	Soil Vapor (µg/L)
Volatile Aliphatic and Aromatic Hydrocarbons								
C5-C8 Aliphatics	NA	2.0E-01	--	5.3E-04	--	1.5E+03	5.3E-04	2.7E+03
C9-C18 Aliphatics	NA	8.6E-02	--	5.3E-04	--	6.3E+02	5.3E-04	1.2E+03
C9-C16 Aromatics	NA	1.4E-02	--	5.4E-04	--	1.0E+02	5.4E-04	1.9E+02
Volatile Organic Compounds (VOCs)								
Chloroform	1.9E-02	8.6E-02	1.1E+00	5.5E-04	2.0E+00	6.3E+02	5.5E-04	1.1E+03
1,2-Dichloroethane (EDC)	7.2E-02	6.9E-01	2.8E-01	5.5E-04	5.2E-01	5.0E+03	5.5E-04	9.1E+03
1,1-Dichloroethylene	NA	2.0E-02	--	5.0E-04	--	1.5E+02	5.0E-04	2.9E+02
cis-1,2-Dichloroethylene	NC	1.0E-02	NC	4.5E-04	NC	7.3E+01	4.5E-04	1.6E+02
Naphthalene	1.2E-01	2.6E-03	1.7E-01	3.9E-04	4.4E-01	1.9E+01	3.9E-04	4.9E+01
Tetrachloroethylene (PCE)	2.1E-02	1.0E-02	9.7E-01	4.4E-04	2.2E+00	7.3E+01	4.4E-04	1.7E+02
Toluene	NA	8.6E-02	--	4.9E-04	--	6.3E+02	4.9E-04	1.3E+03
1,1,1-Trichloroethane	NC	1.4E+00	NC	4.6E-04	NC	1.0E+04	4.6E-04	2.3E+04
Trichloroethylene (TCE)	7.0E-03	1.7E-01	2.9E+00	4.7E-04	6.3E+00	1.3E+03	4.7E-04	2.7E+03
1,2,4-Trimethylbenzene	NA	2.0E-03	--	3.9E-04	--	1.5E+01	3.9E-04	3.7E+01
1,3,5-Trimethylbenzene	NA	1.7E-03	--	3.9E-04	--	1.3E+01	3.9E-04	3.2E+01
m,p-Xylenes	NA	2.0E-01	--	4.6E-04	--	1.5E+03	4.6E-04	3.2E+03
o-Xylene	NA	2.0E-01	--	4.9E-04	--	1.5E+03	4.9E-04	3.0E+03

Notes:
1. Risk-based screening levels (RBSL) calculated using the methodology outlined by OEHHA, 2005, Human-Exposure-Based Screening Numbers Developed to Aid Estimation of Cleanup Costs for Contaminated Soil, January.
2. Chemical-specific alphas calculated using the Johnson and Ettinger Model and default parameters for existing commercial/industrial buildings as outlined by OEHHA (2005). Johnson and Ettinger Model outputs are presented in Attachment C-1.

Abbreviations:
µg/L = micrograms per liter
$\mu g/m^3$ = micrograms per cubic meter
NA = not available
NC = noncarcinogenic
-- = not applicable

Equations:

$$C_{ia-risk} = \frac{TR \times BW \times ATca \times CF_{mg-ug}}{IHR_{ia} \times EF \times ED \times CSF_i}$$

$$C_{ia-haz} = \frac{THQ \times BW \times ATnc \times CF_{mg-ug}}{IHR_{ia} \times EF \times ED \times 1/RfD_i}$$

$$RBSL_{soil\ vapor-ia} = \frac{C_{ia}}{\alpha \times CF_{m3-L}}$$

See Section 4.1

TABLE C-12
RISK-BASED SCREENING LEVELS FOR SOIL VAPOR --
OUTDOOR COMMERCIAL/INDUSTRIAL WORKER EXPOSURE TO AMBIENT AIR
Former Pechiney Cast Plate, Inc. Facility
Vernon, California

Chemical	Inhalation Toxicity Criteria		Diffusivity in Air (Di) (cm^2/sec)	Diffusivity in Water (Dw) (cm^2/sec)	Henry's Law Constant (H) (atm-m^3/mole)	Dimensionless Henry's Law Constant (H') (unitless)	Organic Carbon Partition Coefficient (Koc) (L/kg)	Soil-Organic Partition Coefficient (Kd) (cm^3/g)	Effective Diffusivity (Da) (cm^2/sec)	Soil Vapor RBSL[1] -- Outdoor Commercial/Industrial Worker							
										Cancer				Noncancer			
	Cancer Slope Factor (CSF_i) (mg/kg-day)$^{-1}$	Reference Dose (RfDi) (mg/kg-day)								Ambient Air Screening Level (µg/m^3)	Emission Rate (Ei) (µg/m^2-sec)	Total Solute Concentration (CT) (µg/cm^3)	Soil Vapor Screening Level (µg/L)	Ambient Air Screening Level (µg/m^3)	Emission Rate (Ei) (µg/m^2-sec)	Total Solute Concentration (CT) (µg/cm^3)	Soil Vapor Screening Level (µg/L)
Volatile Aliphatic and Aromatic Hydrocarbons																	
C5-C8 Aliphatics	NA	2.0E-01	1.0E-01	1.0E-05	8.0E-01	3.3E+01	4.0E+03	8.0E+00	2.2E-02	--	--	--	--	1.5E+03	8.6E+01	1.4E+03	2.0E+06
C9-C18 Aliphatics	NA	8.6E-02	1.0E-01	1.0E-05	1.9E+00	7.8E+01	2.5E+05	5.0E+02	1.5E-03	--	--	--	--	6.3E+02	3.7E+01	2.4E+03	2.2E+05
C9-C16 Aromatics	NA	1.4E-02	1.0E-01	1.0E-05	1.2E-02	4.9E-01	2.5E+03	5.0E+00	9.3E-04	--	--	--	--	1.0E+02	6.1E+00	5.0E+02	2.9E+04
Volatile Organic Compounds (VOCs)																	
Chloroform	1.9E-02	8.6E-02	1.0E-01	1.0E-05	3.7E-03	1.5E-01	4.0E+01	8.0E-02	1.1E-02	1.1E+00	6.3E-02	1.5E+00	9.8E+02	6.3E+02	3.7E+01	8.9E+02	5.7E+05
1,2-Dichloroethane (EDC)	7.2E-02	6.9E-01	1.0E-01	9.9E-06	9.8E-04	4.0E-02	1.7E+01	3.5E-02	5.4E-03	2.8E-01	1.7E-02	5.7E-01	1.8E+02	5.0E+03	3.0E+02	1.0E+04	3.2E+06
1,1-Dichloroethylene	NA	2.0E-02	9.0E-02	1.0E-05	2.6E-02	1.1E+00	5.9E+01	1.2E-01	2.6E-02	--	--	--	--	1.5E+02	8.6E+00	1.3E+02	2.4E+05
cis-1,2-Dichloroethylene	NC	1.0E-02	7.4E-02	1.1E-05	4.1E-03	1.7E-01	3.6E+01	7.1E-02	8.8E-03	NC	NC	NC	NC	7.3E+01	4.3E+00	1.1E+02	8.5E+04
Naphthalene	1.2E-01	2.6E-03	5.9E-02	7.5E-06	4.8E-04	2.0E-02	2.0E+03	4.0E+00	2.8E-05	1.7E-01	1.0E-02	4.7E+00	1.4E+01	1.9E+01	1.1E+00	5.2E+02	1.5E+03
Tetrachloroethylene (PCE)	2.1E-02	1.0E-02	7.2E-02	8.2E-06	1.8E-02	7.5E-01	1.6E+02	3.1E-01	1.1E-02	9.7E-01	5.7E-02	1.4E+00	1.3E+03	7.3E+01	4.3E+00	1.0E+02	9.6E+04
Toluene	NA	8.6E-02	8.7E-02	8.6E-06	6.6E-03	2.7E-01	1.8E+02	3.6E-01	5.1E-03	--	--	--	--	6.3E+02	3.7E+01	1.3E+03	4.7E+05
1,1,1-Trichloroethane	NC	1.4E+00	7.8E-02	8.8E-06	1.7E-02	7.0E-01	1.1E+02	2.2E-01	1.4E-02	NC	NC	NC	NC	1.0E+04	6.1E+02	1.3E+04	1.4E+07
Trichloroethylene (TCE)	7.0E-03	1.7E-01	7.9E-02	9.1E-06	1.0E-02	4.2E-01	1.7E+02	3.3E-01	7.2E-03	2.9E+00	1.7E-01	5.0E+00	2.9E+03	1.3E+03	7.4E+01	2.2E+03	1.2E+06
1,2,4-Trimethylbenzene	NA	2.0E-03	6.1E-02	7.9E-06	6.1E-03	2.5E-01	1.4E+03	2.7E+00	5.3E-04	--	--	--	--	1.5E+01	8.6E-01	9.3E+01	5.1E+03
1,3,5-Trimethylbenzene	NA	1.7E-03	6.0E-02	8.7E-06	5.9E-03	2.4E-01	1.4E+03	2.7E+00	5.0E-04	--	--	--	--	1.3E+01	7.4E-01	8.2E+01	4.3E+03
m,p-Xylenes	NA	2.0E-01	7.7E-02	8.4E-06	7.6E-03	3.1E-01	3.9E+02	7.8E-01	2.7E-03	--	--	--	--	1.5E+03	8.6E+01	4.1E+03	9.0E+05
o-Xylene	NA	2.0E-01	8.7E-02	1.0E-05	5.2E-03	2.1E-01	3.6E+02	7.3E-01	2.2E-03	--	--	--	--	1.5E+03	8.6E+01	4.5E+03	7.2E+05

Notes:

1. Risk-based screening levels (RBSL) calculated using the X/Q dispersion model and the VOC Emission Model presented in U.S. EPA, 1996, Soil Screening Guidance: Users Guide and Technical Background Document.

Abbreviations:

atm-m^3/mole = atmospheres - cubic meter per mole
cm^2/sec = square centimeters per second
cm^3/g = cubic centimeters per gram
L/kg = liters per kilogram
µg/cm^3 = micrograms per cubic centimeter
µg/L = micrograms per liter
µg/m^2-sec = micrograms per square meter per second
µg/m^3 = micrograms per cubic meter
NA = not available
NC = noncarcinogenic
-- = not applicable

Equations:

$$C_{oa-risk} = \frac{TR \times BW \times ATca \times CF_{mg-ug}}{IHR_{ia} \times EF \times ED \times CSF_i}$$

$$C_{oa-haz} = \frac{THQ \times BW \times ATnc \times CF_{mg-ug}}{IHR_{ia} \times EF \times ED \times 1/RfD_i}$$

$$E_i = \frac{C_{oa}}{X/Q}$$

$$CT = \frac{Ei \times \sqrt{\pi \times Da \times T}}{2 \times Da \times CF_{m2-cm2}}$$

$$RBSL_{soil\,vapor-oa} = \frac{CT}{[(pb \times Kd/H') + Pw/H' + Pa] \times CF_{cm3-L}}$$

See Sections 4.1 and 4.2

TABLE C-13
RISK-BASED SCREENING LEVELS FOR SOIL VAPOR -- CONSTRUCTION WORKER EXPOSURE TO AMBIENT AIR
Former Pechiney Cast Plate, Inc. Facility
Vernon, California

Chemical	Inhalation Toxicity Criteria		Diffusivity in Air (Di) (cm^2/sec)	Diffusivity in Water (Dw) (cm^2/sec)	Henry's Law Constant (H) (atm-m^3/mole)	Dimensionless Henry's Law Constant (H') (unitless)	Organic Carbon Partition Coefficient (Koc) (L/kg)	Soil-Organic Partition Coefficient (Kd) (cm^3/g)	Effective Diffusivity (Da) (cm^2/sec)	Soil Vapor RBSL[1] -- Construction Worker							
										Cancer				Noncancer			
	Cancer Slope Factor (CSF_i) (mg/kg-day)$^{-1}$	Reference Dose (RfDi) (mg/kg-day)								Ambient Air Screening Level (µg/m^3)	Emission Rate (Ei) (µg/m^2-sec)	Total Solute Concentration (CT) (µg/cm^3)	Soil Vapor Screening Level (µg/L)	Ambient Air Screening Level (µg/m^3)	Emission Rate (Ei) (µg/m^2-sec)	Total Solute Concentration (CT) (µg/cm^3)	Soil Vapor Screening Level (µg/L)
Volatile Aliphatic and Aromatic Hydrocarbons																	
C5-C8 Aliphatics	NA	2.0E-01	1.0E-01	1.0E-05	8.0E-01	3.3E+01	4.0E+03	8.0E+00	2.2E-02	--	--	--	--	1.0E+03	6.0E+01	2.0E+02	2.8E+05
C9-C18 Aliphatics	NA	8.6E-02	1.0E-01	1.0E-05	1.9E+00	7.8E+01	2.5E+05	5.0E+02	1.5E-03	--	--	--	--	4.4E+02	2.6E+01	3.4E+02	3.0E+04
C9-C16 Aromatics	NA	1.4E-02	1.0E-01	1.0E-05	1.2E-02	4.9E-01	2.5E+03	5.0E+00	9.3E-04	--	--	--	--	7.3E+01	4.3E+00	7.0E+01	4.0E+03
Volatile Organic Compounds (VOCs)																	
Chloroform	1.9E-02	8.6E-02	1.04E-01	1.00E-05	3.66E-03	1.50E-01	3.98E+01	7.96E-02	1.07E-02	1.88E+01	1.11E+00	5.33E+00	3.4E+03	4.4E+02	2.6E+01	1.2E+02	7.9E+04
1,2-Dichloroethane (EDC)	7.2E-02	6.9E-01	1.04E-01	9.90E-06	9.77E-04	4.00E-02	1.74E+01	3.48E-02	5.38E-03	4.97E+00	2.93E-01	1.99E+00	6.4E+02	3.5E+03	2.1E+02	1.4E+03	4.5E+05
1,1-Dichloroethylene	NA	2.0E-02	9.00E-02	1.04E-05	2.60E-02	1.07E+00	5.89E+01	1.18E-01	2.61E-02	--	--	--	--	1.0E+02	6.0E+00	1.9E+01	3.3E+04
cis-1,2-Dichloroethylene	NC	1.0E-02	7.36E-02	1.13E-05	4.07E-03	1.67E-01	3.55E+01	7.10E-02	8.77E-03	NC	NC	NC	NC	5.1E+01	3.0E+00	1.6E+01	1.2E+04
Naphthalene	1.2E-01	2.6E-03	5.90E-02	7.50E-06	4.82E-04	1.98E-02	2.00E+03	4.00E+00	2.80E-05	2.98E+00	1.76E-01	1.65E+01	4.9E+01	1.3E+01	7.7E-01	7.3E+01	2.1E+02
Tetrachloroethylene (PCE)	2.1E-02	1.0E-02	7.20E-02	8.20E-06	1.84E-02	7.53E-01	1.55E+02	3.10E-01	1.08E-02	1.70E+01	1.00E+00	4.81E+00	4.5E+03	5.1E+01	3.0E+00	1.4E+01	1.3E+04
Toluene	NA	8.6E-02	8.70E-02	8.60E-06	6.62E-03	2.72E-01	1.82E+02	3.64E-01	5.10E-03	--	--	--	--	4.4E+02	2.6E+01	1.8E+02	6.6E+04
1,1,1-Trichloroethane	NC	1.4E+00	7.80E-02	8.80E-06	1.72E-02	7.03E-01	1.10E+02	2.20E-01	1.37E-02	NC	NC	NC	NC	7.3E+03	4.3E+02	1.8E+03	2.0E+06
Trichloroethylene (TCE)	7.0E-03	1.7E-01	7.90E-02	9.10E-06	1.03E-02	4.21E-01	1.66E+02	3.32E-01	7.24E-03	5.11E+01	3.01E+00	1.76E+01	1.0E+04	8.8E+02	5.2E+01	3.0E+02	1.7E+05
1,2,4-Trimethylbenzene	NA	2.0E-03	6.06E-02	7.92E-06	6.14E-03	2.52E-01	1.35E+03	2.70E+00	5.32E-04	--	--	--	--	1.0E+01	6.0E-01	1.3E+01	7.1E+02
1,3,5-Trimethylbenzene	NA	1.7E-03	6.02E-02	8.67E-06	5.87E-03	2.41E-01	1.35E+03	2.70E+00	5.05E-04	--	--	--	--	8.8E+00	5.2E-01	1.1E+01	6.0E+02
m,p-Xylenes	NA	2.0E-01	7.69E-02	8.44E-06	7.64E-03	3.13E-01	3.89E+02	7.78E-01	2.68E-03	--	--	--	--	1.0E+03	6.0E+01	5.8E+02	1.3E+05
o-Xylene	NA	2.0E-01	8.70E-02	1.00E-05	5.18E-03	2.12E-01	3.63E+02	7.26E-01	2.24E-03	--	--	--	--	1.0E+03	6.0E+01	6.3E+02	1.0E+05

Notes:

1. Risk-based screening levels (RBSL) calculated using the X/Q dispersion model and the VOC Emission Model presented in U.S. EPA, 1996, Soil Screening Guidance: Users Guide and Technical Background Document.

Abbreviations:

atm-m^3/mole = atmospheres - cubic meter per mole
cm^2/sec = square centimeters per second
cm^3/g = cubic centimeters per gram
L/kg = liters per kilogram
µg/cm^3 = micrograms per cubic centimeter
µg/L = micrograms per liter
µg/m^2-sec = micrograms per square meter per second
µg/m^3 = micrograms per cubic meter
NA = not available
NC = noncarcinogenic
-- = not applicable

Equations:

$$C_{oa-risk} = \frac{TR \times BW \times ATca \times CF_{mg-ug}}{IHR_{ia} \times EF \times ED \times CSF_i}$$

$$C_{oa-haz} = \frac{THQ \times BW \times ATnc \times CF_{mg-ug}}{IHR_{ia} \times EF \times ED \times 1/RfD_i}$$

$$E_i = \frac{C_{oa}}{X/Q}$$

$$CT = \frac{Ei \times \sqrt{\pi \times Da \times T}}{2 \times Da \times CF_{m2-cm2}}$$

$$RBSL_{soil\,vapor-oa} = \frac{CT}{[(pb \times Kd/H') + Pw/H' + Pa] \times CF_{cm3-L}}$$

See Sections 4.1 and 4.2

TABLE C-14
RISK-BASED SCREENING LEVELS FOR TPH MIXTURES IN SOIL VAPOR
Former Pechiney Cast Plate, Inc. Facility
Vernon, California

Hydrocarbon Range	Soil Vapor RBSLs -- Noncancer		
	Indoor Commercial/ Industrial Worker (µg/L)[1]	Outdoor Commercial/ Industrial Worker (µg/L)[2]	Construction Worker (µg/L)[3]
c5-c8 Aliphatics	2.7E+03	2.0E+06	2.8E+05
c9-c18 Aliphatics	1.2E+03	2.2E+05	3.0E+04
c9-c16 Aromatics	1.9E+02	2.9E+04	4.0E+03

Chemical	Apportion Method[4]						Worst Case[6]		
	Normalized Percentages Estimated for Each Hydrocarbon Range[5]			Soil Vapor RBSLs -- Noncancer			Soil Vapor RBSLs -- Noncancer		
	C5-C8 Aliphatics	C9-C18 Aliphatics	C9-C16 Aromatics	Indoor Commercial/ Industrial Worker (µg/L)	Outdoor Commercial/ Industrial Worker (µg/L)	Construction Worker (µg/L)	Indoor Commercial/ Industrial Worker (µg/L)	Outdoor Commercial/ Industrial Worker (µg/L)	Construction Worker (µg/L)
TPH as Stoddard solvent	29%	57%	14%	**1.5E+03**	**6.9E+05**	**1.0E+05**	**6.8E+02**	**1.2E+05**	**1.7E+04**

Notes:
1. Soil vapor RBSLs calculated as discussed in Section 4.1 and presented in Table C-11.
2. Soil vapor RBSLs calculated as discussed in Section 4.2 and presented in Table C-12.
3. Soil vapor RBSLs calculated as discussed in Section 4.2 and presented in Table C-13.
4. Apportion method RBSLs calculated by summing the soil vapor RBSLs for c5-c8 aliphatics, c9-c18 aliphatics, and c9-c16 aromatics, weighted by their respective normalized percentages.
5. Normalized percentages estimated as discussed in Section 2.1.1 and presented in Table C-2.
6. Worst case RBSLs calculated assuming Stoddard solvent is composed of 50% aliphatic and 50% aromatic hydrocarbons, and using the most health-protective RBSLs of the volatile aliphatic and aromatic hydrocarbon groups within the mixture (c9-c18 aliphatics and c9-c16 aromatics).

Abbreviations:
µg/L = micrograms per liter
RBSL = risk-based screening level
TPH = total petroleum hydrocarbons

TABLE C-15
RISK-BASED SCREENING LEVELS FOR TPH MIXTURES IN GROUNDWATER
Former Pechiney Cast Plate, Inc. Facility
Vernon, California

Hydrocarbon Range	Groundwater RBSLs -- Noncancer Indoor Commercial/ Industrial Worker (µg/L)[1]
c5-c8 Aliphatics	9.2E+02
c9-c18 Aliphatics	1.7E+02
c9-c16 Aromatics	4.7E+03

Chemical	Apportion Method[2] Normalized Percentages Estimated for Each Hydrocarbon Range[3] C5-C8 Aliphatics	C9-C18 Aliphatics	C9-C16 Aromatics	Groundwater RBSLs -- Noncancer Indoor Commercial/ Industrial Worker (µg/L)	Worst Case[4] Groundwater RBSLs -- Noncancer Indoor Commercial/ Industrial Worker (µg/L)
TPH as Stoddard solvent	29%	57%	14%	**1.0E+03**	**6.8E+02**

Notes:
1. Groundwater RBSLs calculated as discussed in Section 5.0 and presented in Attachment D-2.
2. Apportion method RBSL calculated by summing the soil vapor RBSLs for c5-c8 aliphatics, c9-c18 aliphatics, and c9-c16 aromatics, weighted by their respective normalized percentages.
3. Normalized percentages estimated as discussed in Section 2.1.1 and presented in Table C-2.
4. Worst case RBSL calculated assuming Stoddard solvent is composed of 50% aliphatic and 50% aromatic hydrocarbons, and using the most health-protective RBSLs of the volatile aliphatic and aromatic hydrocarbon groups within the mixture (c9-c18 aliphatics and c9-c16 aromatics).

Abbreviations:
µg/L = micrograms per liter
RBSL = risk-based screening level
TPH = total petroleum hydrocarbons

ATTACHMENT A-1
ADDITIONAL EQUATIONS USED IN SOIL VAPOR SCREENING LEVEL CALCULATIONS
Former Pechiney Cast Plate, Inc. Facility
Vernon, California

Estimation of Chemical Constants: (U.S. EPA, 1996)

$$H' = H / RT \quad (1)$$

H' = Dimensionless Henry's Law Constant
H = Henry's Law Constant (atm-m^3/mole)
R = Universal gas constant (atm-m^3/mole-K)
T = Temperature (K)

$$Kd = Koc \times foc \quad (2)$$

Kd = Soil-organic partition coefficient (cm^3/g)
Koc = Organic carbon partition coefficient (L/kg)
foc = Fraction organic-carbon (unitless)

Supporting Equations: (U.S. EPA, 1996)

$$X/Q = \frac{CF_{kg\text{-}mg}}{Q/C \times CF_{g\text{-}mg}} \quad (3)$$

X/Q = Air dispersion factor (mg/m^3 per mg/m^2-sec)
Q/C = Inverse of dispersion factor (g/m^2-sec per kg/m^3)
$CF_{g\text{-}mg}$ = Conversion Factor from g to mg (mg/g)
$CF_{kg\text{-}mg}$ = Conversion Factor from kg to mg (mg/kg)

$$Q/C = A \times \exp[(\ln Ac - B)^2 \div C] \quad (4)$$

Q/C = Inverse of dispersion factor (g/m^2-sec per kg/m^3)
Ac = Area of site (acres)
A = A Constant (Location - Los Angeles, CA)
B = B Constant (Location - Los Angeles, CA)
C = C Constant (Location - Los Angeles, CA)

ATTACHMENT A-1
ADDITIONAL EQUATIONS USED IN SOIL VAPOR SCREENING LEVEL CALCULATIONS
Former Pechiney Cast Plate, Inc. Facility
Vernon, California

Supporting Equations (continued): (U.S. EPA, 1996)

$$Da = \frac{[\ (Pa^{10/3} \times Di \times H' + Pw^{10/3} \times Dw) / Pt^2\ ]}{pb \times Kd + Pw + Pa \times H'} \qquad (5)$$

Da = Effective Diffusivity (cm^2/sec)
Pa = Air-filled soil porosity (unitless)
Di = Diffusivity in air (cm^2/sec)
H' = Dimensionless Henry's Law Constant
Pw = Water-filled soil porosity (unitless)
Dw = Diffusivity in water (cm^2/sec)
Pt = Total porosity (unitless)
pb = Soil bulk density (g/cm^3)
Kd = Soil-Organic partition coefficient (cm^3/g)

Abbreviations:
atm = atmospheres
cm^2 = square centimeters
cm^3 = cubic centimeters
g = grams
K = kelvin
kg = kilograms
L = liters
m^2 = square meters
m^3 = cubic meters
mg = milligrams
sec = seconds

ATTACHMENT A-2
RISK ASSESSMENT ASSUMPTIONS
Former Pechiney Cast Plate, Inc. Facility
Vernon, California

Parameter	Symbol	Value	Units	Source
Exposure Assumptions				
Target Risk	TR	1.0E-06	unitless	OEHHA, 2005a
Target Hazard Quotient	THQ	1.0E+00	unitless	OEHHA, 2005a
Duration - Commercial/Industrial	T_{ind}	7.9E+08	sec	Calculated
Duration - Construction	T_{cw}	3.2E+07	sec	Calculated
Site Assumptions				
Area of Source	Area	4576	m^2	Site-specific
Area of Source	Area_acres	1.13	acre	Site-specific
A Constant	A	11.91	unitless	Los Angeles
B Constant	B	18.44	unitless	Los Angeles
C Constant	C	209.78	unitless	Los Angeles
Air Dispersion Factor	X/Q	16.96	mg/m^3 per mg/m^2-sec	Calculated
Inverse of Dispersion Factor	Q/C	58.95	g/m^2-sec per kg/m^3	Calculated
Particulate Emission Factor				
Construction Worker	PEFcw	1.00E+06	m^3/kg	DTSC, 2005
Commercial/Industrial Worker	PEFow	1.32E+09	m^3/kg	DTSC, 2005
Temperature	T	295	Kelvin	Default
Soil Constants				
Fraction Organic Carbon	foc	0.002	unitless	Default
Air Filled Soil Porosity	Pa	0.321	unitless	Default for sandy soil type
Water Filled Soil Porosity	Pw	0.054	unitless	Default for sandy soil type
Total Porosity	Pt	0.375	unitless	Default for sandy soil type
Soil Bulk Density	rb	1.66	g/cm^3	Default for sandy soil type
Conversion Factors				
Conversion Factor from cm^3 to L	CF_{cm3-L}	1E-03	L/cm^3	Constant
Conversion Factor from m^3 to L	CF_{m3-L}	1E+03	L/m^3	Constant
Conversion Factor from g to kg	CF_{g-kg}	1E-03	kg/g	Constant
Conversion Factor from g to mg	CF_{g-mg}	1E+03	mg/g	Constant
Conversion Factor from kg to mg	CF_{kg-mg}	1E+06	mg/kg	Constant
Conversion Factor from m^2 to cm^2	CF_{m2-cm2}	1E+04	cm^2/m^2	Constant
Conversion Factor from mg to g	CF_{mg-g}	1E-06	g/mg	Constant

Abbreviations:
cm^2 = square centimeters
cm^3 = cubic centimeters
g = grams
kg = kilograms
L = liters
m^2 = square meters
m^3 = cubic meters
mg = milligrams
sec = seconds

ATTACHMENT B-1

Revised California Human Health Screening Level for Lead

Developed Using U.S. EPA's Adult Lead Model (ALM) (U.S. EPA, 2005)

Outdoor Commercial/Industrial Worker

U.S. EPA Version date 05/19/05

Exposure Variable	Description of Exposure Variable	Units	Region OR Ethnic GSDi and PbBo Data from NHANES III Analysis							
			All/All	All/White	All/Black	All/Mexican	Northeast/All	Midwest/All	South/All	West/All
$PbB_{fetal,\ 0.90}$	90th percentile PbB in fetus	ug/dL	1	10	10	10	10	10	10	10
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
GSD_i	Geometric standard deviation PbB[a]	--	1.8	2.1	2.2	2.3	2.0	2.2	2.1	2.1
PbB_0	Baseline PbB[a]	ug/dL	0.0	1.5	1.8	1.7	2.0	1.5	1.4	1.4
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
$AF_{S,\ D}$	Absorption fraction (same for soil and dust)	--	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
$EF_{S,\ D}$	Exposure frequency (same for soil and dust)[a]	days/yr	250	219	219	219	219	219	219	219
$AT_{S,\ D}$	Averaging time (same for soil and dust)	days/yr	365	365	365	365	365	365	365	365
PRG		**ppm**	**318**	1,288	938	794	1,092	1,079	1,366	1,287

[1] Equation 1 does not apportion exposure between soil and dust ingestion (excludes W_S, K_{SD}).
When $IR_S = IR_{S+D}$ and $W_S = 1.0$, the equations yield the same PRG.

Notes:
a = Default U.S. EPA ALM values replaced by values consistent with OEHHA recommendations (2009).
g = grams
µg/dL = micrograms per deciliter
y = year

ATTACHMENT B-2
LEAD RISK ASSESSMENT SPREADSHEET
CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL
CONSTRUCTION WORKER

USER'S GUIDE to version 7

INPUT	
MEDIUM	LEVEL
Lead in Air (ug/m^3)	0.028
Lead in Soil/Dust (ug/g)	940
Lead in Water (ug/l)	15
% Home-grown Produce	7%
Respirable Dust (ug/m^3)	1.5

OUTPUT

	Percentile Estimate of Blood Pb (ug/dl)					PRG-99	PRG-95
	50th	90th	95th	98th	99th	(ug/g)	(ug/g)
BLOOD Pb, ADULT	6.5	11.9	14.0	17.1	19.4	391	614
BLOOD Pb, CHILD	13.4	24.4	28.9	35.2	40.0	146	247
BLOOD Pb, PICA CHILD	20.0	36.5	43.2	52.5	59.8	94	159
BLOOD Pb, OCCUPATIONAL	3.4	6.1	7.2	8.8	10.0	937	1474

EXPOSURE PARAMETERS

	units	adults	children
Days per week	days/wk	7	
Days per week, occupational		5	
Geometric Standard Deviation		1.6	
Blood lead level of concern (ug/dl)		10	
Skin area, residential	cm^2	5700	2900
Skin area occupational[a]	cm^2	5700	
Soil adherence[a]	ug/cm^2	800	200
Dermal uptake constant	(ug/dl)/(ug/day)	0.0001	
Soil ingestion[b]	mg/day	165	100
Soil ingestion, pica	mg/day		200
Ingestion constant	(ug/dl)/(ug/day)	0.04	0.16
Bioavailability	unitless	0.44	
Breathing rate	m^3/day	20	6.8
Inhalation constant	(ug/dl)/(ug/day)	0.08	0.192
Water ingestion	l/day	1.4	0.4
Food ingestion	kg/day	1.9	1.1
Lead in market basket	ug/kg	3.1	
Lead in home-grown produce	ug/kg	423.0	

PATHWAYS

ADULTS	Residential			Occupational		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	4.4E-4	0.41	6%	3.1E-4	0.29	9%
Soil Ingestion	2.9E-3	2.73	42%	2.1E-3	1.95	58%
Inhalation, bkgrnd		0.05	1%		0.03	1%
Inhalation	2.5E-6	0.00	0%	1.8E-6	0.00	0%
Water Ingestion		0.84	13%		0.84	25%
Food Ingestion, bkgrnd		0.22	3%		0.23	7%
Food Ingestion	2.4E-3	2.25	35%			0%

CHILDREN	typical			with pica		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	5.6E-5	0.05	0%		0.05	0%
Soil Ingestion	7.0E-3	6.62	49%	1.4E-2	13.24	66%
Inhalation	2.0E-6	0.00	0%		0.00	0%
Inhalation, bkgrnd		0.04	0%		0.04	0%
Water Ingestion		0.96	7%		0.96	5%
Food Ingestion, bkgrnd		0.50	4%		0.50	3%
Food Ingestion	5.5E-3	5.21	39%		5.21	26%

Notes:
a Default Lead Spread value replaced by value used in the derivation of other risk-based screening levels (see Table C-6).
b Default Lead Spread value replaced by 50 percent of the soil ingestion rate used in the derivation of other risk-based screening levels.

Attachment C-1: Soil Vapor Attenuation Factors for Vapor Intrusion -- Indoor Commercial/Industrial Worker, Data Entry Sheet

SL-ADV
Version 3.0; 02/03

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES X

Geomatrix Version, 1.0.1
modified by MJC, Jan 2004
includes Cal-EPA CSFs

ENTER
U.S. EPA or
Cal-EPA

Cal-EPA

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (mg/kg)	Chemical
67663		Chloroform
107062		1,2-Dichloroethane
75354		1,1-Dichloroethylene
156592		cis-1,2-Dichloroethylene
91203		Naphthalene
127184		Tetrachloroethylene
108883		Toluene
71556		1,1,1-Trichloroethane
79016		Trichloroethylene
95636		1,2,4-Trimethylbenzene
108678		1,3,5-Trimethylbenzene
106423		p-Xylene
95476		o-Xylene
9999992		C5-C8 Aliphatics
9999994		C9-C18 Aliphatics
9999996		C9-C16 Aromatics

MORE
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ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell G38) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
22	9	49	0	9	10	30	S		

MORE
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ENTER Stratum A SCS soil type	ENTER Stratum A soil dry bulk density, r_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, q_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type	ENTER Stratum B soil dry bulk density, r_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, q_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type	ENTER Stratum C soil dry bulk density, r_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, q_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
S	1.66	0.375	0.054	0.002	S	1.66	0.375	0.054	0.002	SIC	1.80	0.30	0.15	0.002

MORE
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ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, DP ($g/cm-s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
9	40	1000	1000	244	0.1	1	5

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based soil concentration.

END

Attachment C-1: Soil Vapor Attenuation Factors for Vapor Intrusion -- Indoor Commercial/Industrial Worker, Chemical Properties Sheet

	Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henrys law constant at reference temperature, H (atm-m^3/mol)	Henrys law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $DH_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF $(mg/m^3)^{-1}$	Reference conc., RfC (mg/m^3)	Physical state at soil temperature (S,L,G)
Chloroform	1.04E-01	1.00E-05	3.66E-03	25	6,988	334.32	536.40	3.98E+01	7.92E+03	5.3E-06	3.0E-01	L
1,2-Dichloroethane	1.04E-01	9.90E-06	9.77E-04	25	7,643	356.65	561.00	1.74E+01	8.52E+03	2.2E-05	0.0E+00	L
1,1-Dichloroethylene	9.00E-02	1.04E-05	2.60E-02	25	6,247	304.75	576.05	5.89E+01	2.25E+03	0.0E+00	7.0E-02	L
cis-1,2-Dichloroethylene	7.36E-02	1.13E-05	4.07E-03	25	7,192	333.65	544.00	3.55E+01	3.50E+03	0.0E+00	3.5E-02	L
Naphthalene	5.90E-02	7.50E-06	4.82E-04	25	10,373	491.14	748.40	2.00E+03	3.10E+01	0.0E+00	9.0E-03	S
Tetrachloroethylene	7.20E-02	8.20E-06	1.84E-02	25	8,288	394.40	620.20	1.55E+02	2.00E+02	5.9E-06	3.5E-02	L
Toluene	8.70E-02	8.60E-06	6.62E-03	25	7,930	383.78	591.79	1.82E+02	5.26E+02	0.0E+00	3.0E-01	L
1,1,1-Trichloroethane	7.80E-02	8.80E-06	1.72E-02	25	7,136	347.24	545.00	1.10E+02	1.33E+03	0.0E+00	2.2E+00	L
Trichloroethylene	7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	2.0E-06	6.0E-01	L
1,2,4-Trimethylbenzene	6.06E-02	7.92E-06	6.14E-03	25	9,369	442.30	649.17	1.35E+03	5.70E+01	0.0E+00	6.0E-03	L
1,3,5-Trimethylbenzene	6.02E-02	8.67E-06	5.87E-03	25	9,321	437.89	637.25	1.35E+03	2.00E+00	0.0E+00	6.0E-03	L
p-Xylene	7.69E-02	8.44E-06	7.64E-03	25	8,525	411.52	616.20	3.89E+02	1.85E+02	0.0E+00	7.0E-01	L
o-Xylene	8.70E-02	1.00E-05	5.18E-03	25	8,661	417.60	630.30	3.63E+02	1.78E+02	0.0E+00	7.0E-01	L
C5-C8 Aliphatics	1.00E-01	1.00E-05	8.00E-01	25	7,000	369.00	508.00	3.98E+03	5.40E+00	0.0E+00	7.0E-01	0.0E+00
C9-C18 Aliphatics	1.00E-01	1.00E-05	1.90E+00	25	7,000	473.00	568.90	2.51E+05	3.40E-02	0.0E+00	3.0E-01	0.0E+00
C9-C16 Aromatics	1.00E-01	1.00E-05	1.20E-02	25	9,321	473.00	637.00	2.51E+03	2.50E+01	0.0E+00	5.0E-02	0.0E+00

Attachment C-1: Soil Vapor Attenuation Factors for Vapor Intrusion -- Indoor Commercial/Industrial Worker, Intermediate Calculations Sheet

	Exposure duration, t (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, q_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, q_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, q_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (mg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
Chloroform	7.88E+08	40	0.321	0.321	0.150	0.003	1.01E-07	0.998	1.01E-07	4,000	0.00E+00	6.78E+04
1,2-Dichloroethane	7.88E+08	40	0.321	0.321	0.150	0.003	1.01E-07	0.998	1.01E-07	4,000	0.00E+00	6.78E+04
1,1-Dichloroethylene	7.88E+08	40	0.321	0.321	0.150	0.003	1.01E-07	0.998	1.01E-07	4,000	0.00E+00	6.78E+04
cis-1,2-Dichloroethylene	7.88E+08	40	0.321	0.321	0.150	0.003	1.01E-07	0.998	1.01E-07	4,000	0.00E+00	6.78E+04
Naphthalene	7.88E+08	40	0.321	0.321	0.150	0.003	1.01E-07	0.998	1.01E-07	4,000	0.00E+00	6.78E+04
Tetrachloroethylene	7.88E+08	40	0.321	0.321	0.150	0.003	1.01E-07	0.998	1.01E-07	4,000	0.00E+00	6.78E+04
Toluene	7.88E+08	40	0.321	0.321	0.150	0.003	1.01E-07	0.998	1.01E-07	4,000	0.00E+00	6.78E+04
1,1,1-Trichloroethane	7.88E+08	40	0.321	0.321	0.150	0.003	1.01E-07	0.998	1.01E-07	4,000	0.00E+00	6.78E+04
Trichloroethylene	7.88E+08	40	0.321	0.321	0.150	0.003	1.01E-07	0.998	1.01E-07	4,000	0.00E+00	6.78E+04
1,2,4-Trimethylbenzene	7.88E+08	40	0.321	0.321	0.150	0.003	1.01E-07	0.998	1.01E-07	4,000	0.00E+00	6.78E+04
1,3,5-Trimethylbenzene	7.88E+08	40	0.321	0.321	0.150	0.003	1.01E-07	0.998	1.01E-07	4,000	0.00E+00	6.78E+04
p-Xylene	7.88E+08	40	0.321	0.321	0.150	0.003	1.01E-07	0.998	1.01E-07	4,000	0.00E+00	6.78E+04
o-Xylene	7.88E+08	40	0.321	0.321	0.150	0.003	1.01E-07	0.998	1.01E-07	4,000	0.00E+00	6.78E+04
C5-C8 Aliphatics	7.88E+08	40	0.321	0.321	0.150	0.003	1.01E-07	0.998	1.01E-07	4,000	0.00E+00	6.78E+04
C9-C18 Aliphatics	7.88E+08	40	0.321	0.321	0.150	0.003	1.01E-07	0.998	1.01E-07	4,000	0.00E+00	6.78E+04
C9-C16 Aromatics	7.88E+08	40	0.321	0.321	0.150	0.003	1.01E-07	0.998	1.01E-07	4,000	0.00E+00	6.78E+04

	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, h (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $DH_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, m_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
Chloroform	1.00E+06	4.00E-04	9	7,429	3.22E-03	1.33E-01	1.79E-04	1.68E-02	1.68E-02	2.09E-03	2.67E-03	40	9
1,2-Dichloroethane	1.00E+06	4.00E-04	9	8,390	8.46E-04	3.49E-02	1.79E-04	1.68E-02	1.68E-02	2.09E-03	2.68E-03	40	9
1,1-Dichloroethylene	1.00E+06	4.00E-04	9	6,313	2.34E-02	9.65E-01	1.79E-04	1.45E-02	1.45E-02	1.80E-03	2.31E-03	40	9
cis-1,2-Dichloroethylene	1.00E+06	4.00E-04	9	7,612	3.57E-03	1.47E-01	1.79E-04	1.19E-02	1.19E-02	1.48E-03	1.89E-03	40	9
Naphthalene	1.00E+06	4.00E-04	9	12,789	3.87E-04	1.60E-02	1.79E-04	9.54E-03	9.54E-03	1.19E-03	1.53E-03	40	9
Tetrachloroethylene	1.00E+06	4.00E-04	9	9,431	1.56E-02	6.45E-01	1.79E-04	1.16E-02	1.16E-02	1.44E-03	1.85E-03	40	9
Toluene	1.00E+06	4.00E-04	9	9,023	5.67E-03	2.34E-01	1.79E-04	1.41E-02	1.41E-02	1.75E-03	2.23E-03	40	9
1,1,1-Trichloroethane	1.00E+06	4.00E-04	9	7,754	1.50E-02	6.20E-01	1.79E-04	1.26E-02	1.26E-02	1.56E-03	2.00E-03	40	9
Trichloroethylene	1.00E+06	4.00E-04	9	8,407	8.89E-03	3.67E-01	1.79E-04	1.28E-02	1.28E-02	1.58E-03	2.03E-03	40	9
1,2,4-Trimethylbenzene	1.00E+06	4.00E-04	9	11,541	5.04E-03	2.08E-01	1.79E-04	9.80E-03	9.80E-03	1.22E-03	1.56E-03	40	9
1,3,5-Trimethylbenzene	1.00E+06	4.00E-04	9	11,521	4.82E-03	1.99E-01	1.79E-04	9.73E-03	9.73E-03	1.21E-03	1.55E-03	40	9
p-Xylene	1.00E+06	4.00E-04	9	10,107	6.42E-03	2.65E-01	1.79E-04	1.24E-02	1.24E-02	1.54E-03	1.98E-03	40	9
o-Xylene	1.00E+06	4.00E-04	9	10,268	4.34E-03	1.79E-01	1.79E-04	1.41E-02	1.41E-02	1.75E-03	2.23E-03	40	9
C5-C8 Aliphatics	1.00E+06	4.00E-04	9	8,336	6.93E-01	2.86E+01	1.79E-04	1.62E-02	1.62E-02	2.01E-03	2.57E-03	40	9
C9-C18 Aliphatics	1.00E+06	4.00E-04	9	10,761	1.58E+00	6.52E+01	1.79E-04	1.62E-02	1.62E-02	2.01E-03	2.57E-03	40	9
C9-C16 Aromatics	1.00E+06	4.00E-04	9	12,596	9.67E-03	3.99E-01	1.79E-04	1.62E-02	1.62E-02	2.01E-03	2.57E-03	40	9

	Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} (mg/m^3)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^I) (unitless)	Infinite source indoor attenuation coefficient, a (unitless)	Infinite source bldg. conc., $C_{building}$ (mg/m^3)	Finite source b term (unitless)	Finite source y term $(sec)^{-1}$	Time for source depletion, t_D (sec)	Exposure duration > time for source depletion (YES/NO)
Chloroform	7.96E-02	0.00E+00	0.10	8.33E+01	1.68E-02	4.00E+02	2.72E+48	5.47E-04	0.00E+00	NA	NA	NA	NA
1,2-Dichloroethane	3.48E-02	0.00E+00	0.10	8.33E+01	1.68E-02	4.00E+02	2.72E+48	5.48E-04	0.00E+00	NA	NA	NA	NA
1,1-Dichloroethylene	1.18E-01	0.00E+00	0.10	8.33E+01	1.45E-02	4.00E+02	9.30E+55	5.03E-04	0.00E+00	NA	NA	NA	NA
cis-1,2-Dichloroethylene	7.10E-02	0.00E+00	0.10	8.33E+01	1.19E-02	4.00E+02	2.75E+68	4.45E-04	0.00E+00	NA	NA	NA	NA
Naphthalene	4.00E+00	0.00E+00	0.10	8.33E+01	9.54E-03	4.00E+02	2.37E+85	3.86E-04	0.00E+00	NA	NA	NA	NA
Tetrachloroethylene	3.10E-01	0.00E+00	0.10	8.33E+01	1.16E-02	4.00E+02	9.13E+69	4.39E-04	0.00E+00	NA	NA	NA	NA
Toluene	3.64E-01	0.00E+00	0.10	8.33E+01	1.41E-02	4.00E+02	7.91E+57	4.93E-04	0.00E+00	NA	NA	NA	NA
1,1,1-Trichloroethane	2.20E-01	0.00E+00	0.10	8.33E+01	1.26E-02	4.00E+02	3.79E+64	4.61E-04	0.00E+00	NA	NA	NA	NA
Trichloroethylene	3.32E-01	0.00E+00	0.10	8.33E+01	1.28E-02	4.00E+02	5.78E+63	4.65E-04	0.00E+00	NA	NA	NA	NA
1,2,4-Trimethylbenzene	2.70E+00	0.00E+00	0.10	8.33E+01	9.80E-03	4.00E+02	1.32E+83	3.91E-04	0.00E+00	NA	NA	NA	NA
1,3,5-Trimethylbenzene	2.70E+00	0.00E+00	0.10	8.33E+01	9.73E-03	4.00E+02	4.72E+83	3.90E-04	0.00E+00	NA	NA	NA	NA
p-Xylene	7.78E-01	0.00E+00	0.10	8.33E+01	1.24E-02	4.00E+02	3.18E+65	4.57E-04	0.00E+00	NA	NA	NA	NA
o-Xylene	7.26E-01	0.00E+00	0.10	8.33E+01	1.41E-02	4.00E+02	7.91E+57	4.93E-04	0.00E+00	NA	NA	NA	NA
C5-C8 Aliphatics	7.96E+00	0.00E+00	0.10	8.33E+01	1.62E-02	4.00E+02	2.35E+50	5.35E-04	0.00E+00	NA	NA	NA	NA
C9-C18 Aliphatics	5.02E+02	0.00E+00	0.10	8.33E+01	1.62E-02	4.00E+02	2.35E+50	5.35E-04	0.00E+00	NA	NA	NA	NA
C9-C16 Aromatics	5.02E+00	0.00E+00	0.10	8.33E+01	1.62E-02	4.00E+02	2.35E+50	5.35E-04	0.00E+00	NA	NA	NA	NA

ATTACHMENT D-1
SUMMARY OF INPUT PARAMETERS
Risk-Based Screening Levels for Vapor Intrusion from Groundwater
Former Pechiney Cast Plate, Inc. Facility
Vernon, California

Parameter	Value	Rationale
Groundwater Parameters		
Depth Below Grade to Water Table L_{WT} (cm)	4572	Site-specific: Depth to groundwater (150 feet) based on the logs of borings 125 and 126.
Soil Parameters		
Average Soil/Groundwater Temperature, T_s (^oC)	22	Default: Highest California average annual soil temperature as provided by USEPA, 2003 and OEHHA, 2005.
Stratum A Soil Properties		
SCS Soil Type (unitless)	Sand	Site-specific: Soil types provided in the logs of borings 125 and 126 included sands and silts from the surface to approximately 54 feet bgs, where clays were encountered. To be conservative, assumed this combined stratum, from 0 to 54 feet bgs, was sand.
Thickness, h_A (cm)	1646	Site-specific: Depth of initial sand/silt stratum based on the logs of borings 125 and 126.
Soil Dry Bulk Density, ρ_b^A (g/cm^3)	1.66	Default: Default value for sand SCS soil type provided by USEPA, 2003 and OEHHA, 2005.
Soil Total Porosity, n^A (unitless)	0.375	Default: Default value for sand SCS soil type provided by USEPA, 2003 and OEHHA, 2005.
Soil Water-Filled Porosity, θ_w^A (cm^3/cm^3)	0.054	Default: Default value for sand SCS soil type provided by USEPA, 2003 and OEHHA, 2005.
Stratum B Soil Properties		
SCS Soil Type (unitless)	Clay	Site-specific: Clay soil type provided in the logs of borings 125 and 126 at approximately 53 or 54 feet bgs. In boring 125, clays were encountered from 54 to 64 feet bgs, and also from 85 to 89 feet bgs (for a combined 14 feet of clay), with sands and silts in between. In boring 126, clays were encountered from 53 to 63 feet bgs, 104 to 111 feet bgs, and 121 to 125 feet bgs (for a combined 21 feet of clay), with sands and silts in between. To be conservative, Stratum B was assumed to be only 14 feet of clay (based on boring 125), extending from 54 to 68 feet bgs.
Thickness, h_B (cm)	426.72	Site-specific: 14 feet of clay (combined) based on boring 125
Soil Dry Bulk Density, ρ_b^B (g/cm^3)	1.43	Default: Default value for clay SCS soil type provided by USEPA, 2003 and OEHHA, 2005.
Soil Total Porosity, n^B (unitless)	0.459	Default: Default value for clay SCS soil type provided by USEPA, 2003 and OEHHA, 2005.
Soil Water-Filled Porosity, θ_w^B (cm^3/cm^3)	0.215	Default: Default value for clay SCS soil type provided by USEPA, 2003 and OEHHA, 2005.
Stratum C Soil Properties		
SCS Soil Type (unitless)	Sand	Site-specific: Soil types provided in the logs of borings 125 and 126 below clay to groundwater included sands and silts. To be conservative, assumed the combined stratum was sand.
Thickness, h_A (cm)	2499.28	Site-specific: Assumed the lower stratum extended from 68 feet to groundwater (82 feet).
Soil Dry Bulk Density, ρ_b^A (g/cm^3)	1.66	Default: Default value for sand SCS soil type provided by USEPA, 2003 and OEHHA, 2005.
Soil Total Porosity, n^A (unitless)	0.375	Default: Default value for sand SCS soil type provided by USEPA, 2003 and OEHHA, 2005.
Soil Water-Filled Porosity, θ_w^A (cm^3/cm^3)	0.054	Default: Default value for sand SCS soil type provided by USEPA, 2003 and OEHHA, 2005.

ATTACHMENT D-1
SUMMARY OF INPUT PARAMETERS
Risk-Based Screening Levels for Vapor Intrusion from Groundwater
Former Pechiney Cast Plate, Inc. Facility
Vernon, California

Parameter	Value	Rationale
Building Parameters		
Enclosed Space Floor Thickness, L_{crack} (cm)	9	Default: Default value provided by USEPA, 2002, DTSC, 2005, and OEHHA, 2005.
Soil-Building Pressure Differential ΔP (g/cm-s^2)	40	Default: Default value provided by USEPA, 2002, DTSC, 2005, and OEHHA, 2005.
Enclosed Space Floor Length, Width, Height L_B, W_B, H_B (cm)	Length: 1000 Width: 1000 Height: 244	Default: Default values provided by USEPA, 2002, DTSC, 2005, and OEHHA, 2005.
Floor-Wall Seam Crack Width, w (cm)	0.1	Default: Default value provided by USEPA, 2002 and OEHHA, 2005.
Indoor Air Exchange Rate, ER (1/hr)	1	Default: Default value for commercial/industrial buildings provided by DTSC, 2005 and OEHHA, 2005.
Average Vapor Flow Rate into Building Q_{soil} (L/m)	5	Default: Default value provided by USEPA, 2002 and OEHHA, 2005.
Crack-to-Total Area Ratio η (unitless)	0.005	Default: DTSC, 2005.
Exposure Parameters		
Averaging Time for Carcinogens, AT_c (yrs)	70	Default: Default value provided by USEPA, 1991 and OEHHA, 2005 for commercial/industrial workers.
Averaging Time for Noncarcinogens, AT_{nc} (yrs)	25	Default: Default value provided by USEPA, 1991 and OEHHA, 2005 for commercial/industrial workers.
Exposure Duration, ED (yrs)	25	Default: Default value provided by USEPA, 1991 and OEHHA, 2005 for commercial/industrial workers.
Exposure Frequency, EF (days/yr)	250	Default: Default value provided by USEPA, 1991 and OEHHA, 2005 for commercial/industrial workers.

References:

Department of Toxic Substances Control (DTSC), 2005, Guidance for the Evaluation and Migration of Subsurface Vapor Intrusion to Indoor Air, Interim Final, California. Environmental Protection Agency, February 7.

Office of Environmental Health Hazard Assessment (OEHHA), 2005, Human-Exposure-Based Screening Numbers Developed to Aid Estimation of Cleanup Costs for Contaminated Soil, California Environmental Protection Agency, January.

U.S. Environmental Protection Agency (USEPA), 1991, Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors, Office of Emergenc and Remedial Response, Washington, D.C.

USEPA, 2002, "Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)," Draft Federal Register, November 29.

USEPA. 2003. "Draft User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings." Office of Emergency and Remedial Response. March 14.

Attachment D-2: Risk-Based Screening Levels for Vapor Intrusion from Groundwater -- Indoor Commercial/Industrial Worker, Data Entry Sheet

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [ ]

Geomatrix Consultants, Inc.
modified by CAK; 11/05
Mult. Chemical; version 3.1.2

ENTER
U.S. EPA or Cal-EPA

[Cal-EPA]

ENTER Chemical CAS No. (numbers only, no dashes)	**ENTER** Initial groundwater conc., C_W (µg/L)	Chemical	
71432	2.80E+00	Benzene	
67663	1.05E+02	Chloroform	
75354	1.20E+00	1,1-Dichloroethylene	
107062	4.10E+02	1,2-Dichloroethane	
75092	1.00E+01	Methylene chloride	
100414	8.50E-01	Ethylbenzene	
127184	4.60E+00	Tetrachloroethylene	
108883	2.90E+00	Toluene	
79016	4.20E+02	Trichloroethylene	
106423	3.90E+00	p-Xylene	for m,p-xylenes
95476	2.00E+00	o-Xylene	
9999992	1.00E+00	C5-C8 Aliphatics	
9999994	1.00E+00	C9-C18 Aliphatics	
9999996	1.00E+00	C9-C16 Aromatics	

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	**ENTER** Depth below grade to bottom of enclosed space floor, L_F (cm)	**ENTER** Depth below grade to water table, L_{WT} (cm)	**ENTER** Totals must add up to value of L_{WT} (cell G28) Thickness of soil stratum A, h_A (cm)	**ENTER** Thickness of soil stratum B, (Enter value or 0) h_B (cm)	**ENTER** Thickness of soil stratum C, (Enter value or 0) h_C (cm)	**ENTER** Soil stratum directly above water table, (Enter A, B, or C)	**ENTER** SCS soil type directly above water table	**ENTER** Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	**ENTER** User-defined stratum A soil vapor permeability, k_v (cm^2)
22	9	4572	1646	426.72	2499.28	C	S	S		
		150	54	14	82					

Attachment D-2: Risk-Based Screening Levels for Vapor Intrusion from Groundwater -- Indoor Commercial/Industrial Worker, Data Entry Sheet

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
S	1.66	0.375	0.054	CL	1.43	0.459	0.215	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
9	40	1000	1000	244	0.1	1	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

Attachment D-2: Risk-Based Screening Levels for Vapor Intrusion from Groundwater
Indoor Commercial/Industrial Worker, Chemical Properties Sheet

	Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
Benzene	8.80E-02	9.80E-06	5.54E-03	25	7,342	353.24	562.16	5.89E+01	1.79E+03	2.9E-05	6.0E-02
Chloroform	1.04E-01	1.00E-05	3.66E-03	25	6,988	334.32	536.40	3.98E+01	7.92E+03	5.3E-06	3.0E-01
1,1-Dichloroethylene	9.00E-02	1.04E-05	2.60E-02	25	6,247	304.75	576.05	5.89E+01	2.25E+03	0.0E+00	7.0E-02
1,2-Dichloroethane	1.04E-01	9.90E-06	9.77E-04	25	7,643	356.65	561.00	1.74E+01	8.52E+03	2.1E-05	0.0E+00
Methylene chloride	1.01E-01	1.17E-05	2.18E-03	25	6,706	313.00	510.00	1.17E+01	1.30E+04	1.0E-06	4.0E-01
Ethylbenzene	7.50E-02	7.80E-06	7.86E-03	25	8,501	409.34	617.20	3.63E+02	1.69E+02	2.5E-06	2.0E+00
Tetrachloroethylene	7.20E-02	8.20E-06	1.84E-02	25	8,288	394.40	620.20	1.55E+02	2.00E+02	5.9E-06	3.5E-02
Toluene	8.70E-02	8.60E-06	6.62E-03	25	7,930	383.78	591.79	1.82E+02	5.26E+02	0.0E+00	3.0E-01
Trichloroethylene	7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	2.0E-06	6.0E-01
p-Xylene	7.69E-02	8.44E-06	7.64E-03	25	8,525	411.52	616.20	3.89E+02	1.85E+02	0.0E+00	7.0E-01
o-Xylene	8.70E-02	1.00E-05	5.18E-03	25	8,661	417.60	630.30	3.63E+02	1.78E+02	0.0E+00	7.0E-01
C5-C8 Aliphatics	1.00E-01	1.00E-05	8.00E-01	25	7,000	369.00	508.00	3.98E+03	5.40E+00	0.0E+00	7.0E-01
C9-C18 Aliphatics	1.00E-01	1.00E-05	1.90E+00	25	7,000	473.00	568.90	2.51E+05	3.40E-02	0.0E+00	3.0E-01
C9-C16 Aromatics	1.00E-01	1.00E-05	1.20E-02	25	9,321	473.00	637.00	2.51E+03	2.50E+01	0.0E+00	5.0E-02

Attachment D-2: Risk-Based Screening Levels for Vapor Intrusion from Groundwater -- Indoor Commercial/Industrial Worker, Intermediate Calculations Sheet

	Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
Benzene	7.88E+08	4563	0.321	0.244	0.321	0.003	1.01E-07	0.998	1.01E-07	30.00	0.375	0.165	0.210	4,000
Chloroform	7.88E+08	4563	0.321	0.244	0.321	0.003	1.01E-07	0.998	1.01E-07	30.00	0.375	0.165	0.210	4,000
1,1-Dichloroethylene	7.88E+08	4563	0.321	0.244	0.321	0.003	1.01E-07	0.998	1.01E-07	30.00	0.375	0.165	0.210	4,000
1,2-Dichloroethane	7.88E+08	4563	0.321	0.244	0.321	0.003	1.01E-07	0.998	1.01E-07	30.00	0.375	0.165	0.210	4,000
Methylene chloride	7.88E+08	4563	0.321	0.244	0.321	0.003	1.01E-07	0.998	1.01E-07	30.00	0.375	0.165	0.210	4,000
Ethylbenzene	7.88E+08	4563	0.321	0.244	0.321	0.003	1.01E-07	0.998	1.01E-07	30.00	0.375	0.165	0.210	4,000
Tetrachloroethylene	7.88E+08	4563	0.321	0.244	0.321	0.003	1.01E-07	0.998	1.01E-07	30.00	0.375	0.165	0.210	4,000
Toluene	7.88E+08	4563	0.321	0.244	0.321	0.003	1.01E-07	0.998	1.01E-07	30.00	0.375	0.165	0.210	4,000
Trichloroethylene	7.88E+08	4563	0.321	0.244	0.321	0.003	1.01E-07	0.998	1.01E-07	30.00	0.375	0.165	0.210	4,000
p-Xylene	7.88E+08	4563	0.321	0.244	0.321	0.003	1.01E-07	0.998	1.01E-07	30.00	0.375	0.165	0.210	4,000
o-Xylene	7.88E+08	4563	0.321	0.244	0.321	0.003	1.01E-07	0.998	1.01E-07	30.00	0.375	0.165	0.210	4,000
C5-C8 Aliphatics	7.88E+08	4563	0.321	0.244	0.321	0.003	1.01E-07	0.998	1.01E-07	30.00	0.375	0.165	0.210	4,000
C9-C18 Aliphatics	7.88E+08	4563	0.321	0.244	0.321	0.003	1.01E-07	0.998	1.01E-07	30.00	0.375	0.165	0.210	4,000
C9-C16 Aromatics	7.88E+08	4563	0.321	0.244	0.321	0.003	1.01E-07	0.998	1.01E-07	30.00	0.375	0.165	0.210	4,000

	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
Benzene	6.78E+04	1.00E+06	5.00E-03	9	7,998	4.83E-03	1.99E-01	1.79E-04	1.42E-02	3.81E-03	1.42E-02	1.55E-03	1.09E-02	4563
Chloroform	6.78E+04	1.00E+06	5.00E-03	9	7,429	3.22E-03	1.33E-01	1.79E-04	1.68E-02	4.50E-03	1.68E-02	1.84E-03	1.28E-02	4563
1,1-Dichloroethylene	6.78E+04	1.00E+06	5.00E-03	9	6,313	2.34E-02	9.65E-01	1.79E-04	1.45E-02	3.90E-03	1.45E-02	1.59E-03	1.11E-02	4563
1,2-Dichloroethane	6.78E+04	1.00E+06	5.00E-03	9	8,390	8.46E-04	3.49E-02	1.79E-04	1.68E-02	4.51E-03	1.68E-02	1.84E-03	1.28E-02	4563
Methylene chloride	6.78E+04	1.00E+06	5.00E-03	9	6,906	1.94E-03	8.01E-02	1.79E-04	1.63E-02	4.38E-03	1.63E-02	1.79E-03	1.25E-02	4563
Ethylbenzene	6.78E+04	1.00E+06	5.00E-03	9	10,017	6.62E-03	2.73E-01	1.79E-04	1.21E-02	3.25E-03	1.21E-02	1.32E-03	9.26E-03	4563
Tetrachloroethylene	6.78E+04	1.00E+06	5.00E-03	9	9,431	1.56E-02	6.45E-01	1.79E-04	1.16E-02	3.12E-03	1.16E-02	1.27E-03	8.89E-03	4563
Toluene	6.78E+04	1.00E+06	5.00E-03	9	9,023	5.67E-03	2.34E-01	1.79E-04	1.41E-02	3.77E-03	1.41E-02	1.53E-03	1.07E-02	4563
Trichloroethylene	6.78E+04	1.00E+06	5.00E-03	9	8,407	8.89E-03	3.67E-01	1.79E-04	1.28E-02	3.42E-03	1.28E-02	1.39E-03	9.75E-03	4563
p-Xylene	6.78E+04	1.00E+06	5.00E-03	9	10,107	6.42E-03	2.65E-01	1.79E-04	1.24E-02	3.33E-03	1.24E-02	1.36E-03	9.49E-03	4563
o-Xylene	6.78E+04	1.00E+06	5.00E-03	9	10,268	4.34E-03	1.79E-01	1.79E-04	1.41E-02	3.77E-03	1.41E-02	1.54E-03	1.07E-02	4563
C5-C8 Aliphatics	6.78E+04	1.00E+06	5.00E-03	9	8,336	6.93E-01	2.86E+01	1.79E-04	1.62E-02	4.33E-03	1.62E-02	1.76E-03	1.23E-02	4563
C9-C18 Aliphatics	6.78E+04	1.00E+06	5.00E-03	9	10,761	1.58E+00	6.52E+01	1.79E-04	1.62E-02	4.33E-03	1.62E-02	1.76E-03	1.23E-02	4563
C9-C16 Aromatics	6.78E+04	1.00E+06	5.00E-03	9	12,596	9.67E-03	3.99E-01	1.79E-04	1.62E-02	4.33E-03	1.62E-02	1.76E-03	1.23E-02	4563

Attachment D-2: Risk-Based Screening Levels for Vapor Intrusion from Groundwater -- Indoor Commercial/Industrial Worker, Intermediate Calculations Sheet

	Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
Benzene	9	1.99E+02	1.25	8.33E+01	1.42E-02	5.00E+03	3.80E+04	3.42E-05	6.81E-03	2.9E-05	6.0E-02
Chloroform	9	1.33E+02	1.25	8.33E+01	1.68E-02	5.00E+03	7.49E+03	4.02E-05	5.34E-03	5.3E-06	3.0E-01
1,1-Dichloroethylene	9	9.65E+02	1.25	8.33E+01	1.45E-02	5.00E+03	3.00E+04	3.49E-05	3.37E-02	NA	7.0E-02
1,2-Dichloroethane	9	3.49E+01	1.25	8.33E+01	1.68E-02	5.00E+03	7.49E+03	4.02E-05	1.40E-03	2.1E-05	NA
Methylene chloride	9	8.01E+01	1.25	8.33E+01	1.63E-02	5.00E+03	9.77E+03	3.91E-05	3.13E-03	1.0E-06	4.0E-01
Ethylbenzene	9	2.73E+02	1.25	8.33E+01	1.21E-02	5.00E+03	2.36E+05	2.92E-05	7.99E-03	2.5E-06	2.0E+00
Tetrachloroethylene	9	6.45E+02	1.25	8.33E+01	1.16E-02	5.00E+03	3.95E+05	2.81E-05	1.81E-02	5.9E-06	3.5E-02
Toluene	9	2.34E+02	1.25	8.33E+01	1.41E-02	5.00E+03	4.28E+04	3.38E-05	7.91E-03	NA	3.0E-01
Trichloroethylene	9	3.67E+02	1.25	8.33E+01	1.28E-02	5.00E+03	1.26E+05	3.07E-05	1.13E-02	2.0E-06	6.0E-01
p-Xylene	9	2.65E+02	1.25	8.33E+01	1.24E-02	5.00E+03	1.74E+05	3.00E-05	7.95E-03	NA	7.0E-01
o-Xylene	9	1.79E+02	1.25	8.33E+01	1.41E-02	5.00E+03	4.28E+04	3.38E-05	6.05E-03	NA	7.0E-01
C5-C8 Aliphatics	9	2.86E+04	1.25	8.33E+01	1.62E-02	5.00E+03	1.07E+04	3.87E-05	1.11E+00	NA	7.0E-01
C9-C18 Aliphatics	9	6.52E+04	1.25	8.33E+01	1.62E-02	5.00E+03	1.07E+04	3.87E-05	2.52E+00	NA	3.0E-01
C9-C16 Aromatics	9	3.99E+02	1.25	8.33E+01	1.62E-02	5.00E+03	1.07E+04	3.87E-05	1.54E-02	NA	5.0E-02

Attachment D-2: Risk-Based Screening Levels for Vapor Intrusion from Groundwater -- Indoor Commercial/Industrial Worker, Results Sheet

	RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:					INCREMENTAL RISK CALCULATIONS:	
	Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)	Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
Benzene	2.1E+01	1.3E+04	2.07E+01	1.79E+06	2.07E+01	NA	NA
Chloroform	1.4E+02	8.2E+04	1.44E+02	7.92E+06	1.44E+02	NA	NA
1,1-Dichloroethylene	NA	3.0E+03	3.04E+03	2.25E+06	3.04E+03	NA	NA
1,2-Dichloroethane	1.4E+02	NA	1.39E+02	8.52E+06	1.39E+02	NA	NA
Methylene chloride	1.3E+03	1.9E+05	1.31E+03	1.30E+07	1.31E+03	NA	NA
Ethylbenzene	2.0E+02	3.7E+05	2.05E+02	1.69E+05	2.05E+02	NA	NA
Tetrachloroethylene	3.8E+01	2.8E+03	3.83E+01	2.00E+05	3.83E+01	NA	NA
Toluene	NA	5.5E+04	5.54E+04	5.26E+05	5.54E+04	NA	NA
Trichloroethylene	1.8E+02	7.8E+04	1.81E+02	1.47E+06	1.81E+02	NA	NA
p-Xylene	NA	1.3E+05	1.29E+05	1.85E+05	1.29E+05	NA	NA
o-Xylene	NA	1.7E+05	1.69E+05	1.78E+05	1.69E+05	NA	NA
C5-C8 Aliphatics	NA	9.2E+02	9.23E+02	5.40E+03	9.23E+02	NA	NA
C9-C18 Aliphatics	NA	1.7E+02	1.74E+02	3.40E+01	NOC	NA	NA
C9-C16 Aromatics	NA	4.7E+03	4.73E+03	2.50E+04	4.73E+03	NA	NA